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AN ENTOMOLOGIST IN COSTA RICA.*

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Until the separation of Panama as an independent state from Colombia, Costa Rica was the southernmost of the five republics of Central America. It lies between Nicaragua on the north and Panama on the south, from latitude 11° to 8° North. Its general trend is from northwest to southeast, and through its entire length runs a series of peaks, many of them volcanoes, whose greatest altitude is above 12,000 feet. North of the 10th parallel, this chain divides into two branches one of which, extending in a more easterly direction toward the Atlantic, is composed chiefly of the volcanoes Poas (8786 ft.), Barba (9508 ft.), Irazu (11326 ft.) and Turrialba (10965 ft.). The other branch, retaining the southeastward trend, is continued by the Cordillera of Chiriqui in Panama and includes the highest elevations in the country. Along the 10th parallel the distance from the Atlantic to the Pacific is 185 miles, but if we measure to the eastern shore of the Gulf of Nicoya, that is from the port of Limon to Puntarenas, 125 miles. The railroad in making this transit climbs to 5000 feet and this ascent together with its windings increases the actual distance to 175 miles.

The prevailing easterly trade winds coming from the Caribbean, laden with moisture, strike against the lofty mountains and cause a heavy precipitation on the Atlantic slope throughout much of the year. Sheltered by the same peaks the Pacific slopes and even some localities on the Atlantic, like Cartago, receive a smaller precipitation until southerly winds bring moisture from April to November.

*Abstract of address before the Entomological Society of America, Cleveland, Ohio, Jan. 1, 1913. The address was illustrated by a very fine series of lantern views from photographs of insects and localities of scientific and scenic interest. —ED.

Passing from east to west, the average annual rainfall at Limon is 126.8 inches, Juan Viñas 85.6, Cartago 60.7, with minimal average monthly precipitations of 5, 2.5 and 1 inch respectively (all these on the Atlantic slope), while corresponding figures on the Pacific slope are 76 inches for Tres Rios, 76.4 for San Jose and 62.1 for Nuestro Amo, the minimal average monthly rainfalls being .12, .43 and 0 inches respectively.

The abundant rainfall gives rise to many streams of all sizes. Erosion and the undermining of the loose soil have cut the surface of the land into many deep ravines and canyons, producing a rugged topography and making travel difficult and time-consuming. Within short horizontal distances are great differences of elevation. This, in turn, has affected the character of the vegetation and of the fauna. Pronounced segregation of many living things is consequently often the case, and the richness of the biota, as estimated by the number of species, is greatly increased.

Pittier, in 1908, gave the number of species of flowering plants of Costa Rica as 3441; the corresponding number for New Jersey is 1351 (Stone, 1910). Carriker, in 1910, listed 753 species and subspecies of birds from Costa Rica, or more than half the total number (1196) for America north of Mexico in the A. O. U. check list of the same year, and twice as many as have been recorded in recent years for Maine (327), Colorado (392) or Washington (372); the smallest of these three has an area at least a third greater than that of Costa Rica which is only 23,000 square miles. Rehn, in 1905, gave a partial list of 195 species of Costa Rican Orthoptera, as against 154 species in the far more thoroughly explored state of New Jersey. Godman and Salvin, in 1901, enumerated 236 genera of Costa Rican butterflies; Dyar, in 1902, recognized 152 genera for America north of Mexico. Schaus has found 150 Costa Rican species of the butterfly genus *Thecla*, as contrasted with 56 species in America north of Mexico.

All of these characteristics make Costa Rica a Paradise to the naturalist. Its variety of altitude offers variety of temperature. The short distance from the shores of the Atlantic to those of the Gulf of Nicoya, an arm of the Pacific, and the existence of the transcontinental railroad render it possible to pass from one to the other in ten hours; a comparison of conditions at similar altitudes on the two slopes of the divide may be easily

and quickly made. In the higher parts of the country the climate is salubrious and invigorating, and with a little care one may safely investigate the heated lowlands. Proximity to South America, with no intervening barrier, has permitted the invasion of many denizens of the Southern Continent, while not a few cases of continuous distribution from North America are also in evidence. The most orderly of Central American countries holds its presidential elections with as much enthusiasm and with less disturbance than those of the United States. A peaceful and hospitable people and an enlightened government render the stranger's visit an event to be remembered by him with delight throughout a lifetime.

In one or other of these qualities, Costa Rica is excelled by Mexico, Colombia or Brazil, but by none in the totality of the advantages which it offers to the students of all the branches of ecology in its widest sense. One shadow, indeed, hangs over the fair land—that of the earthquakes which within two centuries have thrice destroyed the town of Cartago, lying on the southern slopes of the volcano Irazu, the latest destruction being that of May 4, 1910, when it was serving as our own headquarters.

During the year, May 1909, to May, 1910, insects, especially Odonata (dragonflies) were collected and studied at the following fourteen groups of places and at intervals, in order to obtain data on seasonal distribution.

On the Atlantic slope:

Banana River region, 50 feet, November.
Guapiles, 984 feet, June, November.
Peralta, 1088 feet, August, March.
Turrialba, 2000 feet, July.
Juan Viñas, 2500–4000 feet, June, August, October, December, February, March April.
Cachi, 3600 feet, March.
Cartago, 4750 feet, every month.
Volcano Irazu, 4750–11300 feet, July, September, March.

On the Pacific slope:

Tres Rios and La Carpintera, 4260 to 5700 feet, December, March.
Alajuela, 3100 feet, September, December.
Turrucares, 1800–2200 feet, August, December, April.
Surubres, 800 feet, October.
Puntarenas, 10 feet, February.
Guanacaste, 0–2200 feet, January.

Four of these localities are here described briefly.

Juan Viñas, on the Atlantic slope, was particularly fruitful as a collecting ground owing to its combination of many of the advantages mentioned above. The railroad station, 73 miles from Limon, and at an altitude of 3300 feet, is on the bottom of an old crater the rim of which, at the general level of the country, is 700 feet higher; the village of Juan Viñas is at this latter elevation. From the railway, in half an hour, one may reach the Rio Reventazon, 800 feet below. The canyon of this river thus has a depth of 1500 feet, and presents a great variety of slow- and of swift-flowing brooks, cascades, waterfalls, forest, swamp, bare rock and dense vegetation. It was productive of material illustrating previously unknown life-histories of interesting Odonata (*Cora*, *Mecistogaster*, *Thaumatoneura*, *Philogenia*, *Palaemnema*, etc.).

Surubres, on the Pacific side, at an altitude of about 800 feet, was a favorite with the late Professor Paul Biolley, where he gathered much insect material subsequently sent to entomologists in the United States and in Europe. A week was spent in the hacienda, which he occupied on several occasions, but at a different time of year, to secure data to supplement those which he obtained.

The northwestern province of Costa Rica, Guanacaste, has been little visited by entomologists. Thanks to Professor J. F. Tristan, the writer accompanied an official educational commission thither, and collections and observations were made at Filadelfia, Liberia, Santa Cruz, and Hacienda Guachipelin. The last named, at an altitude of 1700 feet, is not far from the still unexplored Volcano Rincon de la Vieja.

Cartago, near the top of the Atlantic slope of the railroad, was, until its destruction, alluded to above, a convenient center for visits to various parts of the country and served as the breeding place of living material collected on these excursions.

(Other aspects of this visit to Costa Rica have been described in *Entomological News*, vol. XXI, pp. 334–337, July, 1910, and in *Old Penn Weekly Review of the University of Pennsylvania*, vol. IX, pp. 165–170, Nov. 12, 1910. Some of the results obtained from studies on Costa Rican Odonata have been published in *Entomological News* for 1910, 1911 and 1912, and will probably be continued in subsequent volumes of the same journal.)

DETERMINING THE FLIGHT OF MOSQUITOS.

By JAMES ZETEK, Entomologist,
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INTRODUCTION.

This report presents a method for determining the flight factors of mosquitos. The scheme was developed and tried out on the canal zone and has given results which warrant its publication. Apart from its purely scientific standpoint, the knowledge of the flight of Culices enables us to direct better our efforts toward the eradication of these insects from our habitations, and thus greatly reduce the possibilities for transmission of such diseases as yellow-fever, malaria, dengue, etc., and to a large measure do away with the insect as a pest.

DESCRIPTION.

Briefly stated, adult mosquitos are bred, colored with an anilin dye and then liberated at stations about the town selected for study. Systematic collections of adults are made in the buildings of this town, and these adults are tested for the presence of color.

A. GENERAL CONSIDERATION.

Dispersal includes *everything* involved in the movements of animals from one place to another. It is a more or less eccentric movement because the paths taken are usually those of least resistence and economy. In mosquitos, dispersal is limited to four general means: (1) flight of the adult, (2) the adults may be carried by the wind, (3) they may be carried in trains, other vehicles, on the clothing of man or on other animals, and (4) the eggs, larvæ, pupæ and to some extent the adults, may be carried down stream or across a pond by current or wind action.

Such mosquitos as transmit diseases to man, especially when they serve as intermediary hosts in such transmission, are usually limited in their breeding area to the vicinity of human habitations. This is well illustrated by *Aedes calopus* Meigen which transmits yellow fever, and *Anopheles albimanus* Wiedemann, responsible for E. A. malaria. Such mosquitos (verified by us in the two cited species) are not distant travellers, and if they do come from distant places, it is through gradual infiltration. Some species of *Culex* are powerful fliers; others apparantly remain only near their breeding place.

To merely liberate colored adults is almost futile. The study is an ecological one and requires a knowledge of all the physical, biotic and historic factors that in any way enter into the environment of the species studied. The statements given under the three subheads following are not intended to be exhaustive, and they must be amplified according to the species selected.

1. Physical Factors.

A good map of the region selected for experimentation is necessary. It must indicate with fair accuracy the topography, commercial projects, habitations, streets, roads, and inlets of oils or poisonous refuse into streams or ponds and the extent of this pollution.

A recording anemometer should be in operation at the central station, and in addition to the velocity per hour intervals, should give the eight main directions. If more than one such instrument is available, the others may be distributed at stations where decided wind deviations take place. Small portable anemometers will greatly augment the data. A self-recording rain guage is a valuable addition.

The necessity of a well-kept, tabulated record for the data should not have to be mentioned. The following reproduction of an arrangement found satisfactory in our work may be of help to other investigators. This method gives the investigator

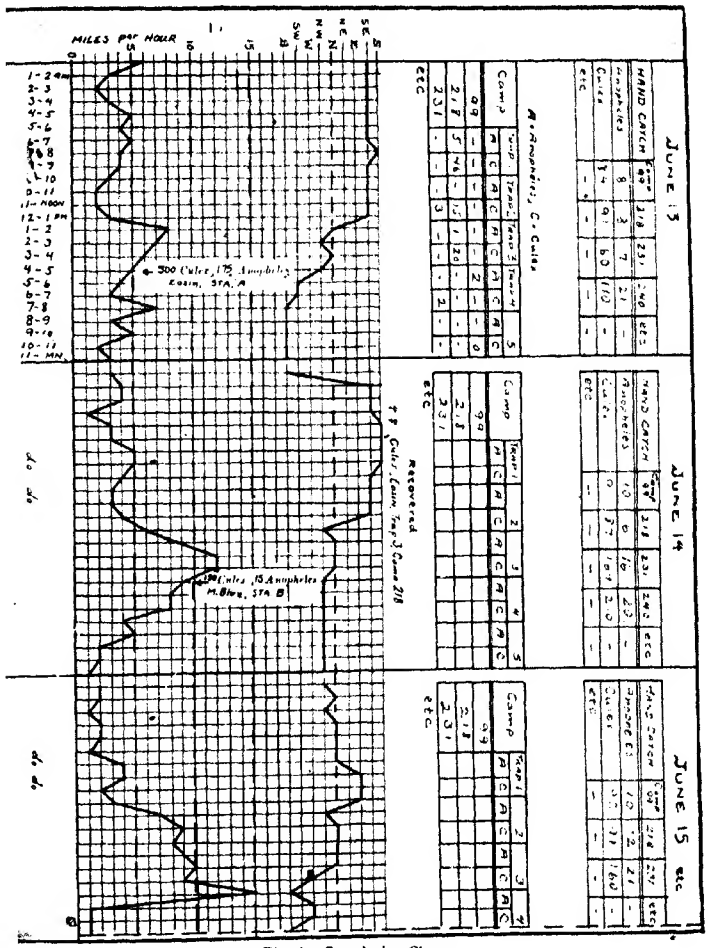

Fig. 1. *Correlation Chart.*

at a glance four distinct data, graphically placed in proper relation to each other, viz: (1) the velocity and direction of the wind per hour intervals, for six or more days, according to the size of paper used; (2) the quantity, species, and sex of mosquitos liberated, time and place of liberation and the color used; (3) the quantity, species, sex, source and color of recovered adults, and (4) the total mosquito catch in all buildings. A simple system of cross-reference to data sheets containing details will save time and energy.

Tracing cloth, so ruled that the ordinates correspond to the above form, can have recorded thereon the quantity and duration of rainfall, cloudbursts, fogs, barometric pressure, frosts, etc. By superposition on the above tabulated form, the relation, if any, of these factors to flight, will be seen. A similar tracing, made to correspond to the map, should indicate the extent of prairies, forests, forest fires, drainage, marshes, the geology of the region, etc.

Porcelain cup evaporimeters should be installed at many stations to determine the relative humidity.

2. Biotic Factors.

Weekly or biweekly surveys of the entire area should be made for the purpose of locating mosquito breeding areas. These should be charted on smaller maps. If portions of this area are oiled, treated with larvacides, or subjected to noxious fumes, the extent of such pollution should be clearly indicated on the maps. It is necessary to know the time interval from oviposition to the adults for the species studied. When searching for *Anopheles*, particularly the malaria-transmitter, a safe rule is to go to unfrequented places, small puddles in grass land, etc.

Most mosquitos, particularly the blood-suckers, are most active during and after dusk. It is evident, then, that an investigator should be detailed for night observations. A sweep-net should be used for beating the grass and shrubbery for mosquitos, traps may be set out to intercept or attract adults, or the observer may remain quiet, expose his arm, and note the ferocity of the biting.

The abundance or scarcity of such predacious animals as dragon flies, robber flies, ants, toads, frogs, fish, bats, etc., should be noted. Marked oscillations in the numbers of mos-

quitos will occur through the ravages of these animals. Collections of these forms must be made and the stomachs examined. The best time for such collection is at or just after dusk when they feed upon these dainty morsels. Unless the stomachs are examined that evening, they should be preserved in 95% alcohol, containing about one percent of thymol, the latter to arrest enzymic action.

Life history studies should be made at the laboratory and all possible data bearing on the ecological problem collected.

3. Historic Factors.

This includes the geology of the region, the plant and animal association and their past history and present trend, past human disturbances still exerting an influence on the biota, and the past history of the mosquitos studied.

B. DETAILED DESCRIPTION.

Mosquitos are delicate organisms, the majority of the species unable to endure intense dry heat, absence of water or shelter, high winds, heavy rains, etc. They are dainty morsels to hosts of alert forms. So far as our experiments are concerned, additional factors enter to lessen the number of released adults which may be recovered. First, the female almost exclusively is able to suck blood. Second, mosquitos are not dependant upon human blood alone. We have noted mosquitos sucking the blood of horses, mules, dogs, cats, monkeys and fowls. The need, then, for releasing large numbers of colored adults is evident. Better results will follow if thousands of mosquitos are liberated.

1. Collection and Care of Larvæ and Pupæ.

A. Collection: Mature or nearly mature larvæ and all pupæ, of the species selected for study, should be collected. Young larvæ thrive poorly in the field laboratory. All predacious larvæ must be excluded from the receptacles containing larvæ and pupæ.

A white enameled or porcelain saucer is very satisfactory in "dishing-up" water and algæ to note whether mosquito larvæ are present. The larvæ, if there, stand out in bold relief against the white back-ground. If the larvæ and pupæ are abundant, a large white enameled dressing bucket (such as is used by hospitals) should be used to dip up quantities of the

water and algæ. This prevents frequent disturbance of the water, and allows the frightened mosquitos to regain their equilibrium. When dishing-up the water, a shadow should not pass over the surface of the pond, as this causes the larvæ to wriggle away. The algæ in the bucket should be removed after the larvæ clinging to them have been dislodged. The contents of the bucket may then be strained through a clean piece of surgical gauze. In this manner the larvæ and pupæ are not lost, while the very young larvæ, small debris, etc., are allowed to wash into the pond or stream. The gauze should be inverted over a wide-mouthed jar, and water applied very carefully with a pipette to the larvæ. These are thereby released from the gauze and placed in the jars. Small pails are as servicable as jars.

The receptacles containing the larvæ and pupæ must be kept in a cool, shaded spot, otherwise the water will quickly foul. Not more than one and a half inches of water should be allowed in these jars. The larvæ should not be left in these containers for more than one half a day. Overcrowding must be avoided and at least once each half day the water should be aerated. A Paquelin Cautery bulb, with a capillary tube attached, serves well this object, and one or two bulbfuls will be found ample.

B. Transportation: The larvæ in these wide-mouthed jars should be taken each half day to the field laboratory, and here emptied into plates or larger receptacles. Prior to transportation, the jars should be placed into a basket and separated from each other with excelsior or cotton wadding, and while carried, shaking must be reduced to a minimum. Constant shaking prevents the larvæ from reaching the surface of the water to breathe and hence repeated unsuccessful attempts to reach the surface bring fatigue and a large percent if not all of the larvæ succumb as a result. Protection from heat and direct light must be considered. The jars themselves must be covered with a close-mesh gauze to prevent the escape of adults emerged en route. If larvæ or pupæ are transported in trains or vehicles, extra precaution should be taken regarding shaking, and additional precaution to prevent inquisitive people from handling these jars and shaking them "to see the wrigglers wriggle,"

Mosquito larvæ and pupæ must be considered as delicate organisms and rough treatment en route makes nil the whole day's work and gives but little encouragement for further work.

C. The Field Laboratory: The field laboratory is a necessity, but it need not consist of more than a small screened house, about eight feet square, protected from direct sunlight and heat. If located convenient to the breeding places, the collected larvæ will suffer but little from jarring en route. Several such houses may be erected at convenient places, however, for all purposes one such house will suffice. It means a concentration of the collected larvæ at one place and one attendant can give these his undivided attention. No staining of adults should be made at the laboratory as this would involve transferring of colored adults and the possible escape en route of some of these.

D. Breeding-out Methods: As soon as the larvæ and pupæ in the wide-mouthed carrying jars reach the field laboratory, they should be transferred into a large pan. The pupæ should be picked out by means of a pipette and confined in jars, these covered with gauze.

White enameled or porcelain soup plates gave the best results as breeding receptacles for the larvæ. If the plates are tilted slightly, both shallow and deep water is afforded to the larvæ. Debris and filamentous algæ should be reduced to a minimum. The food of the larvæ should be known; if diatomaceous, a few pebbles covered with diatoms will suffice. Predacious larvæ of all sorts must be eliminated. Some species of mosquitos prefer sunlight, others do not, or there is preference for foul water, etc. These peculiarities must be known. *Successful breeding depends upon a careful attendance to the peculiar environmental factors of each species.*

Unless the water in the dishes is changed weekly, fouling will ensue and cause heavy mortality. This is obviated by pouring the contents of the dishes over a piece of clean surgical guaze and then inverting over a clean plate containing fresh water. The larvæ when in contact with the water will free themselves from the meshes of the cloth. Sudden additions of fresh water were found to be detrimental; best results were obtained with water which had been standing in the room for twenty-four hours. Careful observance to these environmental requirements has reduced mortality among our own larvæ from ten percent to less than one percent.

The water in the breeding dishes must be aerated twice daily. The Paquelin Cautery bulb method referred to on page 10 does well when the number of places is few. When these plates are numerous, it is better to construct an aerating device such as shown in figure 2, using old tins, tubing, etc. There

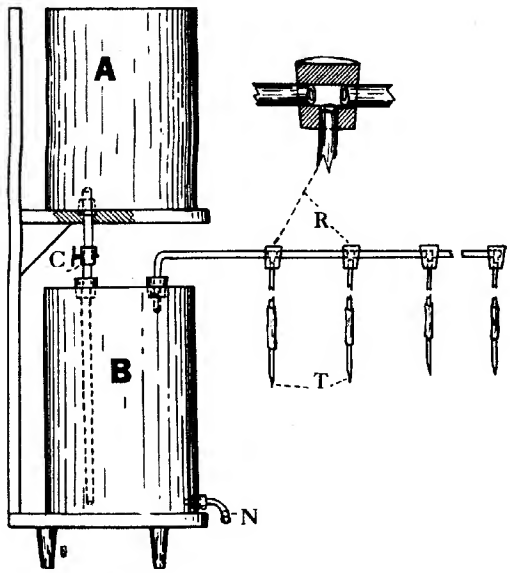

Fig. 2. *Aerating Device.* A, water reservoir, open at top; B, air chamber; C, stop-cock regulating flow of water into B; R, tee unions made of cork; T, terminal capillary tubes.

should be as many feeders as there are dishes to aerate. To set the apparatus into operation, adjust feeders to plates, fill chamber "A" with water and open stop-cock leading to the air chamber.

The writer noted on four occasions a large roach drinking water from breeding pans, at the same time devouring larvæ. On seven occasions ants were seen reaching after such larvæ as were near the edge of the plates and while under observation, two larvæ were successfully withdrawn from the water. These observations suggest strongly the need of protection against these inroads. Keep lookout for mice.

Frequently through chemical or physical changes in the water, produced by excess of heat or food, improper food or foreign substances, waste, etc., the larvæ become sluggish and pupation is greatly retarded. If the cause is not due to fouling of the water, then table salt added not in excess of three percent, will make the larvæ active and accelerate pupation. The dead or sick larvæ in such pans should be eliminated.

Pupæ should be segregated from the breeding dishes daily, preferably morning and evening. They should be confined in wide-mouthed jars, the depth of water not exceeding one and one half inches, and the number of pupæ not more than two hundred and fifty. The mouths of these jars should be provided with paper cones, the tip truncated, and both cone and neck of the jar inserted into a screen cage as shown in figure 3.

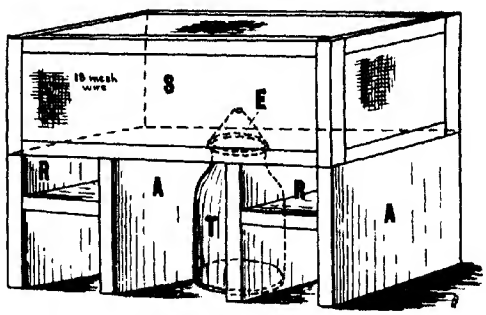

Fig. 3. *Breeding-out Cage.* S, screen cage, hinged back; A, wooden "H" supports; R, lofts for wetted waste; T, jar containing pupæ; E, truncated paper cone trap.

The cone acts as a trap, thus preventing the adults which enter the cage from returning into the jar and being drowned. All crevices about the jars and in the cages must be stopped with cotton waste.

It is advisable to place moist cotton on the floor of the screen cage, also to fill cavities "A" of the "H" supports with wet waste. The top ought to be covered with a wet cloth. These simple measures keep the inside of the cage cool and sweet, and adults can be kept in good condition for at least six days. The cages must be protected from direct sunlight, heat and rain. If ants are present, isolation by water barriers is necessary.

Several times the writer noted roaches in the cages, and the crops of the dissected roaches, as well as the appearance of the adults in the cages, showed the "why" of their presence.

2. The Care of Adults.

A. At the Field Laboratory: It is necessary each morning to remove the jars containing pupæ from the screen cages. It will be found that no few adults remain on the sides of the glass jars. These are readily transferred into the screen cage by holding the cage in direct sunlight and tapping the jar briskly with the hand. When the jars are removed, the holes in the cage which served to receive them, must be plugged snugly with cotton waste to prevent the escape of any adults. The cage must now be placed in a sheltered corner and left for several hours, or until the chitinous portions of the exoskeleton have hardened and the wings stiffened. Precaution must be taken against the invasions by ants and roaches. Avoid rapid evaporation and direct sunlight.

B. Transporting Adults to Stations: Colored adults should not be carried to several localities, the danger of the accidental escape of a colored one en route being too great. Adults, unstained, are best transported in the morning or evening, and each cage should be securely closed and partly encased in a damp cloth. The uncovered side should be underneath. An oil cloth cover is neccessary during showers. In two instances, when no covers were used, and the cages carried through light showers, all the adults were killed. Protection from wind was found necessary. Air currents cause rapid evaporation which the mosquitos cannot withstand.

3. Coloring of the Adults.

A. Dyes Used: Aqueous solution of eosin, fuchsin, gentian-violet, bismarck-braun, methylene-blue and orange-g, were used with good success, the proportions of dry stain to water being about one gram to fifty cc. It is best to make small quantities at a time as stock solutions may deteriorate. All stains should be kept locked up. Likewise staining operations should be known only to a few. Curiosity too frequently gives birth to trouble.

It may not be amiss to state under this section two other "markers" which may be used effectively with larger diptera. In our work they were not as serviceable as the dyes. The

first is a 1 : 20 aqueous solution of phenolphthalein. It was found satisfactory on typhoid flies and is detected readily when a drop or two of one percent solution of ammonium or sodium hydroxide is added to the suspected specimen. A deep red color indicates presence of the drug. The second agent is corn starch and it is detected by applying tincture of iodin, a purple color ensuing in its presence. We had no opportunity to give this latter method a fair trial.

B. Staining the Adults: The mosquitos in the rectangular screen cages should be stained preferably toward evening, about two hours before they are to be released, and always at the station where they will be liberated. A shelter must be provided for these cages. The stains must be applied lightly and must be dry on the insects before they may be allowed freedom. Small globules of water on the wings weight these down to such an extent that the mosquito cannot fly, and it is then easily captured by ants, roaches or more alert forms.

The aqueous solution of the anilin dyes is converted unto a very fine spray through a vaseline-nebulizer, or a fine atomizer, and this spray is allowed to *fall* upon the mosquitos. Direct and forceful projection of the stain against the sides of the mosquito is productive only of death to the insects. Too concentrated solutions must be avoided. The idea is not to encrust the mosquito with the stain, but to place a minute speck only upon the body. Hundreds of tests, using mere specks of the stain gave perfect results when tested for color. The danger of too-protracted a staining is that spiracles become sealed with the stain, mouth parts glued together, sensory areas covered, wings folded, etc.; in other words the mosquitos are no good.

After the mosquitos have been liberated, the cage should be washed in clear water to dissolve all superfluous stain adhering to the screening or sides of the cage. Such crusts, if allowed to remain, create a foulness about the cage which is detrimental to the mosquitos confined therein. It is best, though the statement seems hardly necessary, to keep separate cages for each color used.

To remove stains from fingers and hands, received during the coloring operations, wash hands in acid alcohol. The best way is to use rubber post-mortum gloves when staining mosquitos.

4. Liberating Colored Adults.

The experiments conducted on the canal zone suggest the advisability of liberating adults at or about dusk, or from then on till midnight. The stations selected may be few or many, depending upon the complexity of the physical and biotic factors presented at the time. All that is necessary for liberation is for someone to open the lid of the cage containing the colored mosquitos. This observer should note the time when he liberated the mosquitos, the climatic conditions at the time, and the direction taken by the mosquitos. If people move about near the place of liberation, particularly after dusk, and go to the town from there, this should be carefully noted. The person delegated for this duty should be a keen observer, and honest, too.

The habits of the mosquitos vary with the species—not all cry for the warm blood of man. Then there are some that can't be without it. The writer liberated in the bush, about one quarter miles from Corozal, Canal Zone, at eleven a. m., about fifty stained *Anopheles albimanus* Wiede., and noted three of these soon clinging to his dark colored trousers, and by walking slowly—just as the natives do—he brought these with him into the town of Corozal. This illustrates one of the avenues of dispersal, practically independant of wind, and we must reckon with it, especially since this species is responsible for most of the malaria on the canal zone.

A precaution, based on the above observation, was found necessary. *Brush your clothing* carefully after liberating colored mosquitos, and if possible, *wear a light colored suit.* The latter suggestion proved very helpful. Note also if people passing along the highways, walk toward or from the townsite, and whether they saunter or walk fast, or are quiet or boisterous.

5. Collection and Examination of Adults in Buildings

The recovery of liberated mosquitos in the buildings will demand thorough search and great precaution. Unless this is done, much fruit cannot be expected for the labors and patience expended.

A. Collection by Hand: Hand collections in the buildings are best made at dawn and just at dusk, the mosquitos at these two periods trying to get out and into, respectively, of the

buildings. The men selected for this work should be provided with a killing-tube made of a heavy walled test tube, 6 inches by 1¼ inches, containing a four inch cotton plug saturated with chloroform, over which are a few circular pieces of blotter paper. The collector merely superimposes the mouth of his tube over the mosquito he sees on the wall or clothing, the chloroform vapor, readily generated by the aid of the heat of his palm, quickly kills the insect. A few days' work will render the novice an expert. All the mosquitos caught in one day in one building should be placed by the collector into a circular pill box, of which he should have a good supply. This box should be labeled, giving the date, house, and the initials of collector. At the close of day, these boxes should be turned over to the person in charge, who should check them and rectify any existing errors. The next step is to examine these captured mosquitos for color. (See pp. 19-20).

B. Collection by Traps: If the buildings are *well-screened* and holes and crevices blocked, mosquito traps may be used to excellent advantage. This is being done on the canal zone,

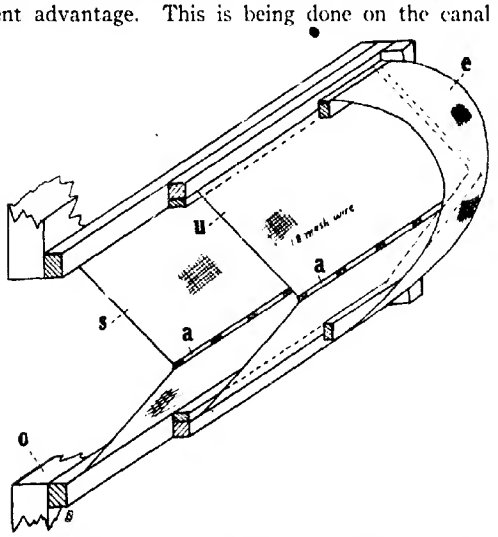

Fig. 4. *Mosquito trap*, in section. **s**, inner "V" section; **u**, middle "V" section; **a**, slits in the "V" sections; **e**, semicircular outer envelope; **o**, sill of building. The "V" sections are detachable.

and the trap illustrated was developed by Mr. Chas. H. Bath, sanitary inspector. Such or similar traps greatly add to the data, and if placed to buildings that harbor a large number of people asleep, will attract many mosquitos, save them, and in regions of malaria, greatly reduce the number of such cases. The traps should be numbered and recorded on charts where their location with respect to the wind is seen at a glance.

Traps should be taken down each morning, at about nine o'clock was found best, and the adults in these killed and placed into pill-boxes, one box for each trap, and each box properly labeled. There is no apparent need for blocking up the opening in the wall when the traps are removed. During five months with these traps, the writer never found a single mosquito that entered during the daytime. The method used was to place a new trap in the place of the one taken out.

A very satisfactory and quick way to kill the mosquitos in the traps is to place the trap into a closed chamber and fumigate with sulphur dioxide. The question arises whether or not this gas combines with the moisture in the mosquito to form sulphurous acid (H_2SO_3), and whether or not this will bleach what color is on the mosquitos. The data following, of a series of tests made, indicate the negative is true:

50 Culex sp. Stained lightly with eosin, left in SO_2 chamber for 3 hrs.; no bleaching.

100 Culex sp. Stained lightly with eosin; 100 Culex sp. with gentian-violet, exposed 13 hrs.; no bleaching.

30 Culex, 70 *Anopheles albimanus* et *malefactor* stained lightly with methylene-blue, exposed to burning sulphur and generated steam for 3½ hrs.; O. K.

10 Culex sp. each slightly stained with all stains cited, exposed 15 minutes; no bleaching.

Paper and blotters, wetted and colored, exposed for 6 hrs.; no bleaching; no acid reaction to litmus.

Vials containing 1 : 10000 aqueous solutions of bismarck-braun, methylene-blue, gentian-violet and eosin, exposed 3½ hrs.; no bleaching; no acid reaction.

C. Collection in Tents. If patient and honest men are procurable, army tents may be pitched at suitable places radiating from the releasing point, and these men placed, one to a tent, with a lantern, killing tube and boxes, to catch all mosquitos that enter the tent. The lamp should burn dimly,

and the men cautioned to be as quiet as possible, and if they must move about, to so do with little commotion. Contrary behavior shews mosquitos away. It seems these gnats wait at the door till the occupant is quiet. The mosquitos caught in a given tent during each hour interval, should be placed in a pill-box, and this one properly labeled, containing in addition to what had already been indicated, the particular hour's catch represented.

D. Collections with a Beating Net: Important clues bearing directly upon the movements of adult mosquitos will be obtained by systematic sweeping in the grass and shrubbery, using for this purpose a large entomological beating net. The adults thus captured should be placed into pill-boxes, these labeled to show the place where caught, character of the vegetation, and hour when captured. The note book should contain data concerning the temperature, wind direction, velocity, humidity, cloudiness, smoke, etc. The writer noted from a series of sweepings that *Anopheles albimanus* Wiede. and certain Culices (*C. quinquefasciatus* Say et *Mansonia titillans* Walker) were more abundant in the grass when the winds were above four miles per hour, than when these winds were less. Its bearing upon the problem can only be determined after a series of careful tests.

E. Examination of Adults: The mosquitos in a single pill-box should be emptied upon a piece of glass plate under which is a white blotter or paper. With a camel's hair brush these are spread over the plate and each specimen is wetted with a testing solution containing three parts of glycerine, three of alcohol and one of chloroform. If any color is present upon any mosquito, it will be revealed as soon as the testing solution reaches it, diffusing outward. Thus each colored specimen becomes a distinct nucleus of diffusion—hence non-colored adults cannot receive through accident some of the diffusing color and thus confuse the observer. The number, species, sex, date and where captured, of all recovered mosquitos, should appear on the data sheets and charts. In addition, a record should be kept of the total mosquito catch, properly tabulated.

It is advisable that only one person be detailed for this examination, and care must be exercised to select a man free from either amnesic or general color blindness. His working table must be kept clean. He should make preliminary tests

to note the action and peculiarity of each color when tested. Accidental rupture of the abdomen of a mosquito, thus extruding the contained blood, should cause no confusion as this blood does not diffuse as does a stain, and furthermore, after a few minutes in the solution, it turns brown. If a spectroscope is available, all colors recovered should be confirmed. As a precaution, all tested mosquitos should be destroyed daily. It is advisable that each day's catch be examined as soon as possible, and whenever delay is necessary, afford protection from ants.

SUMMARY.

1. It is essential, first of all, to have a good map of the territory, to keep a record of climatic conditions, to know the topography and plant associations, the species of mosquitos studied, etc.

2. Larvæ and pupæ must be collected in large numbers, cared for at a field laboratory and the adults that emerge kept in first class condition until ready to be colored and released.

3. These adults must be stained lightly and carefully, without injury to the insect, and the stain allowed to dry on the mosquitos before they are released. Color at liberating station.

4. Release the adults, noting conditions under which this is done. Brush your clothing.

5. Collect daily as with a fine comb, the mosquitos that entered the buildings, tents, and traps. Test these for any color present.

6. *Lastly, interpret rightly your results.*

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The writer is particularly indebted to Colonel W. C. Gorgas, Chief Sanitary Officer, Isthmian Canal Commission, for permission to contribute and publish this paper.

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November 25, 1912.

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A REVISION OF THE NORTH AMERICAN SPECIES OF THE DIPTEROUS GENUS NEURIGONA. (DOLICHOPODIDÆ.)

M. C. VAN DUZEE.

The Dipterous genus *Neurigona* was established by Rondani in Dipt. Ital. prodromus in 1856, with one species, *quadrifasciata* Fabr., which is therefore the type of the genus. In 1829 Thomas Say described an American species as *Medeterus lateralis*. Dr. Loew in 1864 published three others, *dimidiata*, *rubella*, and *tenuis*, and in 1869 a fourth, *carbonifer*. In 1899 W. M. Wheeler added two more, *floridula* and *lienosa*, thus giving us seven described species from America north of Mexico. From farther south Prof. Aldrich has described *decora* and *signifer* from Grenada and St. Vincent, and J. R. Schiner has given us *brasiliensis* from Brazil. These are all the species previously described from America so far as I can learn.

The genus *Neurigona* as characterized by Dr. Loew under the name *Saucropus* in his Monograph of the Dolichopodidæ of North America are:

"First joint of the antennæ without hair on the upper side; arista dorsal; thorax with a sloping area upon the middle of its posterior end; feet very long and slender; hind tibiæ elongated, the first joint of hind tarsi without bristles, shorter than the second; abdomen elongated and narrow, especially in the male; hypopygium disengaged, short and stout, inflected, with short very little developed appendages; color of the body principally or at least partially yellow; hairs and bristles mostly black."

The above characters serve to define the genus as I use it in the present paper but there are some exceptions that should be noted. The bristles of the dorsum of the thorax are always black, thus separating the species of this genus from those of the genus Chrysotimus where they are yellow, but those of the abdomen are often pale as are also the hairs especially in the male. There is a group of western species which are entirely or almost entirely blackish; the first joint of the hind tarsi is sometimes longer than the second, as is the case in *superbiens* Loew, which is synonymous with *lateralis* Say, and fully as long in the male of *tenuis* Loew, also longer in *australis* n. sp.

In the table of genera of the Dolichopodidæ in Williston's Manual of the North American Diptera under No. 28 we have to take fourth vein converging towards the third in order to

run a specimen through to the genus *Neurigona*. In most of our species this is true but there are several exceptions. Dr. Loew in his Monograph of the Dolichopodidæ says that in the South African species the third and fourth veins are parallel, which is also the case with *N. signifer* Aldrich, and in one or two of the species described in this paper. I might add that the abdomen of the female is prolonged into more or less of an ovipositor, as this character is of importance in separating this genus from *Xanthochlorus* where the female abdomen is blunt or rounded at the tip.

Fred Kowarz in Wiener Entomologische Zeitung, II, p. 51, uses the following characters in taking a specimen through to the genus *Neurigona:* "Acrostichal bristles present, in two rows; Arista dorsal; Fourth longitudinal vein not forked; hind coxæ with a single erect bristle on the outside; body color not metallic." These characters hold good in all of the species included in this paper that I have seen except that in *N. albospinosa* n. sp. there are several weak and one stronger bristle on the outside of the hind coxæ; and the last character given would have to be used in a qualified sense.

There are a few characters which are common to most if not all of our species: The lateral and lower orbital cilia are always pale, as are also the cilia of the tegulæ. The hind coxæ have a single large black bristle on the outside, except in *albospinosa* n. sp. which has one large and several weaker whitish bristles on the outside of the hind coxæ. There are two large black bristles on the margin of the scutellum, and in most of our species there is a pair of weak bristles or hairs outside of these. In all of our species that I have examined, and in the two European species that I have seen, (*4-fasciata* Fab. and *suturalis* Fall.), there are one or more pale yellowish bristles above the front coxæ; and often a black bristle on the middle and hind trochanters. The hairs on the legs are arranged in longitudinal rows, and the lower surface of the femora are usually bare. The males of many of our species have a ventral extension of the fifth segment of the abdomen into which the hypopygium partly fits when bent under the abdomen as it is ordinarily carried, I have called these extensions sheaths, they are bilobed, and form characters that can sometimes be used in separating the species.

Most of our species of *Neurigona* are found on the trunks of trees but I sometimes take specimens, mostly of the *rubella* group, while sweeping. In most cases these insects will fly to a tree and alight instantly and rest in one position until they are disturbed or wish to change their location when they make a quick short flight alighting generally a little distance higher up or sometimes to one side, seldom or never lower down. I have often seen them start near the ground and work upwards in short flights until they disappeared from view at a height of perhaps eighteen feet. The male often comes to a tree and flies upward in a perfectly vertical line about two inches from the trunk until it disappears from sight or alights about twelve feet or more above the ground; it may be looking for the female or possibly seeking its prey. In several instances I have seen individuals feeding on Psocid larva.

I have watched the courtship of the males a number of times, they hover over the female for a few seconds and then try and alight upon her, but only once did I see the union consummated, in all other cases the female darted away.

As far as I can learn the only species in our fauna that has been bred is *N. viridis* n. sp. Mr. James Angus, of West Farms, N. Y., makes the following note on this species: "Larva feeding in rotten wood of hickory." We have no description of this larva or pupa, but a pupa case is mounted with Mr. Angus' specimen in the National Museum collection.

The sexes of this genus seem to be unevenly distributed. At one time I will take nearly all males, at another mostly females. One afternoon I took seven males and thirty-five females of *tenuis*, while the next morning in woods a mile and a half distant I took twenty-two males and but nine females of the same species. At another time I took fourteen males of *floridula* var. *infuscata* and no female, but with them were several males and females of *deformis* n. sp. At another time I took many males of *tarsalis* in one spot with females of two other species, and a half mile farther on found both males and females.

The drawings for this paper were made with a camera lucida by Mr. William Wild, of East Aurora, N. Y. The drawings of the hypopygiums give a good idea of the general appearance but no attempt was made to go into anatomical details.

I wish to acknowledge my indebtedness to those who have sent me material for study, and thereby made the revision of this genus possible. To Prof. J. M. Aldrich for the loan of his material, and his help during the preparation of this paper; to the authorities of the National Museum for the loan of specimens, and to Mr. Knab for his help in looking up references in the National Museum library; to Mr. Nathan Banks, Prof. C. W. Johnson, Prof. A. L. Melander, and Mr. V. A. E. Daecke, for the loan of their material; and to Mr. E. T. Cresson for the loan of the material of the American Entomological Society.

TABLE OF SPECIES.

MALES.

1. Dorsum of the thorax mostly black, green or blue 2
   Dorsum largely yellow 17
2. Hypopygium yellow 3
   Hypopygium black or testaceous 7
3. Dorsum of the thorax bright blue. (West Indies) ..... 16 **decora**
   Dorsum black or greenish 4
4. Abdomen with black bands 5
   Abdomen marked with green 6
5. Front tibiæ with a row of bristles above, front tarsi plain ..... 27 **tibialis**
   Front tibiæ plain, third joint of front tarsi white, fourth and fifth joints black ..... 23 **tarsalis**
6. Adbomen marked with brilliant green, appendages of the hypopygium small. (Eastern species) ..... 25 **lateralis**
   Abdomen marked with darker green, appendages long well developed. (Western species) ..... 26 **setosa**
7. Abdomen yellow with black bands 8
   Abdomen nearly uniform, color blackish 15
8. Costa strongly arcuated. (Figs. 17 and 18) 9
   Costa normal 10
9. Front tarsi with the second, third and fourth joints flattened and fringed with hairs ..... 18 **deformis**
   Front tarsal joints not flattened, fifth black and bent at a right angle. ..... 17 **arcuata**
10. Thorax bright shining green. ..... 15 **viridis**
    Thorax if green dull 11
11. Front tarsi plain 14
    Front tarsi ornamented 12
12. Front tarsi black, fringed on each side with short hairs. ..... 28 **ciliata**
    Front tarsi with an oval tip 13
13. Front tarsi two-thirds as long as their tibiæ ..... 20 **pectoralis**
    Front tarsi about as long as their tibiæ ..... 19 **tenuis**
14. Pluræ and dorsum blackish ..... 21 **aestiva**
    Pluræ and sides of dorsum yellow, most of dorsum black and polished. ..... 5 **nitida**
15. Front tarsi plain ..... 31 **albospinosa**
    Front tarsi with an oval tip 16
16. Front tibiæ longer than their tarsi ..... 29 **perbrevis**
    Front tibiæ shorter than their tarsi ..... 30 **australis**
17. Front tarsi ornamented 18
    Front tarsi plain 19
18. Front tarsi with an oval tip ..... 4 **carbonifer**
    Front tarsi with the second joint flattened and widened at the tip, other joints cylindrical ..... 12 **aldrichi**

19. Abdomen yellow with black bands....22
Abdomen yellow without black bands....20
20. Fourth joint of front tarsi nearly two-thirds as long as third, last four joints infuscated....14 **disjuncta.**
Fourth joint only about one-third as long as third, fifth joint black....21
21. Wings hyaline, tinged with yellow, veins yellow....9 **floridula**
Wings with a cloud at tip, tinted with brownish, veins brownish.... 10 **floridula** var. **infuscata**
22. Dorsum of the thorax with the flattened space before the scutellum yellow..23
Dorsum with the flattened space blue or black....24
23. Dorsum of the thorax yellow, immaculate....14 **disjuncta**
Dorsum with two or three black spots....8 **maculata**
24. Flattened space before the scutellum a beautiful greenish blue (West Indies)....7 **signifer**
Flattened space black....25
25. All the hairs and bristles of the front and middle coxæ yellow....3 **dimidiata**
Hairs and bristles of the middle coxæ mostly black....26
26. Front tibiæ with a row of bristles....27 **tibialis**
Front tibiæ plain....27
27. Front metatarsi about one and one-fourth times as long as their tibiæ. 1 **rubella**
Front metatarsi about equal to their tibiæ....2 **perplexa**

FEMALES.

1. Dorsum of the thorax largely yellow....16
Dorsum mostly blue, green, or blackish....2
2. Dorsum of the thorax bright shining blue. (West Indies)....3 **decora**
Dorsum green or blackish....3
3. Dorsum bright shining green....15 **viridis**
Dorsum dull greenish or blackish....4
4. Dorsum dull greenish....5
Dorsum black or gray....14
5. Tip of the fourth vein ending distinctly before the apex of the wing....6
Tip of the fourth vein ending in the tip of the wing, or nearly so....7
6. Tergum of the last two segments of the abdomen dull green, middle and hind femora each with a bristle near the tip....26 **setosa**
Tergum with more or less brilliant green, femora without a bristle near the tip....25 **lateralis**
7. Abdomen fasciate....9
Abdomen of nearly uniform color....8
8. Large species, 4.5 mm. (New Mexico)....30 **australis**
Smaller species, 2 mm. (Eastern species)....32 **minuta**
9. Wings strongly tinged with yellow on the costal edge....10
Wings nearly uniform grayish hyaline....11
10. Wings with distinct clouds at the tips of third and fourth veins....18 **deformis**
Wings evenly tinged along the front, not darker at tip....17 **arcuata**
11. Dorsum of the thorax covered with brown pollen which nearly hides the ground-color. (Calf.)....24 **lienosa**
Dorsum with grayish, or white pollen....12
12. Pleuræ and dorsum without yellow, except the humeri and sometimes the lateral edges and posterior angles....13
Pleuræ and dorsum with considerable yellow....19 **tenuis**
13. Pleura and dorsum without yellow except the humeri....20 **pectoralis**
Dorsum with the humeri, lateral edges to the base of the wings, and the posterior angles yellow....23 **tarsalis**
14. Dorsum black with the humeri, lateral edges, and two stripes extending forward on each side of the flattened space yellow....6 **tridens**
Dorsum of the thorax gray....15
15. Dorsum of the thorax with three metallic brown vittæ....31 **albospinosa**
Dorsum with two nonmetallic brown vittæ....22 **bivittata**

16. Dorsum of the thorax with the flattened space before the scutellum black, gray, green, or blue 17
Dorsum with the flattened space yellow 25
17. Flattened space on the dorsum a beautiful greenish blue ..... 7 **signifer**
Flattened space black, gray, or dull green 18
18. Flattened space on the dorsum and more or less of the dorsum dull green. ..... 19 **tenuis**
Flattened space black or gray 19
19. Flattened space and most of the dorsum gray ..... 22 **bivittata**
Flattened space black 20
20. Dorsum of the thorax and the black central line shining ..... 5 **nitida**
Dorsum less shining, and without distinct central line 21
21. Dorsum with the anterior half and three stripes extending backward black ..... 6 **tridens**
Dorsum with only the flattened space black 22
22. Front metatarsi only three-fourths as long as their tibiæ. ..... 4 **carbonifer**
Front metatarsi about equal to their tibiæ 23
23. First and second joints of hind tarsi equal ..... 3 **dimidiata**
Second joint of hind tarsi longer than the first 24
24. Posterior cross-vein rectangular ..... 1 **rubella**
Posterior cross-vein a little oblique ..... 2 **perplexa**
25. Abdomen fasciate with black 26
Abdomen not distinctly fasciate 27
26. Dorsum of the thorax without black spots. Length 3 mm ..... 12 **aldrichii**
Dorsum with three black spots. Length 4.5–5 mm ..... 8 **maculata**
27. Dorsum of the thorax dull with thick yellow pollen 28
Dorsum shining, only thinly pollenose, pollen whitish 29
28. Dorsum evenly and thickly pollenose ..... 11 **flava**
Dorsum with pollenose vittæ ..... 18 **transversa**
29. Tips of third and fourth veins widely separated ..... 14 **disjuncta**
Tips of third and fourth veins approximated 30
30. Veins yellow ..... 9 **floridula**
Veins brownish ..... 10 **floridula** var. **infuscata**

1 **Neurigona rubella** Loew.

Figure 1.

Saucropus rubella Loew, Neue Beitr., viii, p. 76, 1861; Mon. N. Am. Diptera, ii, p. 226, 1864.

Thorax and abdomen yellow, the former with the flattened space before the scutellum black, the latter with black bands; hypopygium black; front metatarsi about one and one fourth times as long as their tibiæ, with bristles below. Length 5 mm.

Male: Face very narrow, almost linear, and with the palpi silvery white; proboscis yellow; antennæ deep yellow, the first joint paler, arista yellowish brown; front and occiput black, the ground color concealed by thick white pollen. Dorsum of the thorax reddish yellow with the flattened space before the scutellum black and covered with whitish pollen; humeri and pleuræ pale yellow, the latter with white pollen, and with a black spot in front of the halters; metanotum black, with the sides yellowish. Abdomen yellow, dorsum of the second, third, and fourth segments with black bands, that on the second near the base and narrowing at the extreme lateral edges, that on the third at the base and of equal width throughout, the one on the fourth at base and narrowed at the sides not reaching the lateral edges, but forming a subtriangular spot; fifth segment straight above with the front and hind angles square, the upper edge infuscated, and with the

ventral sheath black; the hairs on the dorsum of the abdomen appear reddish or yellowish when viewed from above, but more blackish when seen from the side; hypopygium small, testaceous, rounded above, with yellow hairs on the upper part, appendages partly yellowish. Legs yellowish; front coxæ with delicate yellow hairs on the front surface and yellow bristles near the tip, these bristles brownish in certain lights; middle coxæ with black hairs and bristles on the front side near the tip, and some very minute yellow hairs above; hind coxæ with the usual black bristles on the outside, there is also a small bristle on each middle and hind trochanter; front metatarsi one and one-fourth times as long as their tibiæ, the remaining four tarsal joints taken together somewhat shorter than their tibiæ, second and third joints brownish; front tibiæ and tarsi with the hairs long, and with a row of longer hair-like bristles on the lower surface of the tibiæ and the first three joints of the tarsi, these hairs nearly as long as the diameter of the tarsal joints, there is also a row of shorter and stouter hairs on the upper surface of these joints; middle metatarsi about as long as their tibiæ, the remaining four joints together abount one-fifth shorter than their tibiæ; hind tarsi about as long as their tibiæ, second joint a little longer than the first; middle and hind tarsi brown from the tip of the first joint. Wings hyaline, tinged with yellowish in front of the third vein; posterior cross-vein perpendicular to the fifth vein; third vein bent backward at tip, fourth vein quite sharply arched forward from a little beyond the middle of its last section and ending rather close to the tip of the third vein; tip of the fourth vein distinctly before the apex of the wing; posterior cross-vein about twice its length from the wing margin measured on the fifth vein; veins brownish.

Female: Differs from the male in having the bristles of the front coxæ black, these bristles are large and conspicuous; the front tarsi are brownish and hardly twice as long as their tibiæ, the first joint hardly as long as their tibiæ; middle metatarsi a little shorter than their tibiæ; second joint of hind tarsi only slightly longer than the first.

Dr. Loew says in his description of this species that the metanotum is black only on its base and along the center. I have specimens before me which exactly agree with this, but others have the metanotum almost entirely black, only a very little yellowish at the sides.

I have described the male of this species from two specimens: one in the National Museum collection, taken by Mr. Burgess at Beverly, Mass., September 6, 1874, and the other (a broken specimen) taken at Sea Cliff, N. Y., by Mr. Nathan Banks. The males seem to be rare, although the females are taken all through the eastern states quite commonly; I have taken them around Buffalo, N. Y., and have seen specimens from Connecticut, Massachusetts, New Jersey, Pennsylvania, Virginia, and Kansas. Mrs. Slosson reports it from New Hampshire.

Note.—The females of the five following species which have the dorsum of the thorax yellow, and the flattened space before the scutellum black can be separated as follows: *nitida* differs from the other four by having a central shining black line on the dorsum; *carbonifer* has the front metatarsi only three-fourths as long as their tibiæ, while in *dimidiata*, *rubella*, and *perplexa*, the front metatarsi are nearly equal to their tibiæ; in *dimidiata* it is fully as long, and in the others hardly as long as their tibiæ, *dimidiata* has the first and second joints of the hind tarsi equal, while in the other two the second joint is distinctly the longest, in the last two the bend in the last section of the fourth vein is sharper, and the tarsi are darker than in *dimidiata;* the only difference between the females of *rubella* and *perplexa* that I can see is that in *rubella* the posterior cross-vein is rectangular while in *perplexa* it is a little oblique, but it is difficult to separate them.

I have compared the female of the European species *N. quadrifasciata* Fab. which is the type species of the genus, and closely related to this group, and find that it differs from all of our five species mentioned above, by having the third and fourth veins more widely separated at the tips, the fourth vein ending in the apex of the wing, while in our species the fourth vein ends distinctly before the apex of the wing. Fig. 28 is the apical part of the wing of *quadrifasciata* Fab.

I have also examined *N. suturalis* Fall. of Europe, and find it quite distinct from any of our species.

2 **Neurigona perplexa** n. sp.

Figure 2.

Thorax and abdomen yellow, the former with the flattened space before the scutellum black, and the latter with black bands; hypopygium black, small. Hairs and bristles of the front coxæ whitish; front metatarsi about the length of their tibiæ. Length 1½ mm.

Male: Face very narrow, eyes almost touching on the center of the face, leaving only a small triangle above and below, face and palpi silvery white; proboscis and antennæ yellow, arista brownish; front and occiput black, covered with white pollen; frontal and post-vertical bristles black; orbital cilia whitish. Thorax yellow; the humeri and lateral edges of the dorsum whitish yellow; flattened space before the scutellum black, with white pollen; a dark central line on the dorsum between the acrostichal bristles, reaching from the black flattened space to the front of the dorsum (this may not be found in all specimens); pleuræ pale yellow, with white pollen, and the usual black spot in front of the halters; scutellum yellow with a black spot at base; bristles of

the thorax black, those on the posterior part large, a space on each side above the humeri and reaching about half way to the root of the wings covered with short black bristles; metanotum black with yellow on the sides. Abdomen yellow with black bands at the base of the second, third, and fourth segments, these bands narrowed laterally, hardly reaching the sides below, and emarginate on the center of the dorsum; fifth segment small, with the ventral sheath black; hairs of the abdomen black, those on the fifth segment, and a few along the sides yellow; hypopygium black or testaceous, small, subquadrate, and rounded behind. Legs pale yellow; front coxæ with yellow hairs and bristles; middle coxæ with black hairs and bristles; front metatarsi about the length of their tibiæ, the four remaining joints together about the length of the first, the fourth joint very slightly flattened, third joint nearly twice the length of the fourth; hairs on the front tarsi quite long; middle metatarsi about as long as their tibiæ; hind tarsi with the second joint longer than the first. Wings hyaline, hardly tinged with grayish; veins yellowish brown; posterior cross-vein somewhat oblique.

Female; I place with the male described above a single female closely related to rubella, but somewhat smaller and with the posterior cross-vein a little oblique; it agrees with the male in all but sexual characters.

Described from one male in the National Museum collection, taken at Lehigh Gap, Pa., July 23, 1907, by C. T. Greene; and one female sent me by Prof. C. W. Johnson and labeled Capens, Me., July 21, 1901.

Note.—This is closely related to *rubella* and *nitida*, but the male differs from the later by having only a black central line on the dorsum of the thorax, the abdominal bands are emarginate, the front tarsi have shorter hairs below, the fourth joint is very slightly flattened, and the posterior cross-vein is twice its length from the wing margin measured on the fifth vein, in *nitida* it is less than twice its length from the margin and the fourth joint of front tarsi is cylindrical. From *rubella* it differs in having the front of the wing less arched; all the tarsi are darkened from the base a little, but the dark part not as distinctly marked as in *rubella*, the front metatarsi are about the same length as their tibiæ while in *rubella* they are very distinctly longer. In *rubella* the third and fourth joints of the front tarsi are about equal while in this species the third is nearly twice as long as the fourth. This species is a little smaller than *rubella* and the posterior cross-vein is a little oblique while in *rubella* it is perpendicular to the fifth vein. It differs from *dimidiata* by having black hairs and bristles on the middle coxæ, while *dimidiata* has only yellowish hairs and

bristles on the middle coxæ; *dimidiata* also has pale hairs on most of the first four segments of the abdomen while in this species they are mostly black, the front of the wing in this species is also more arched.

3 **Neurigona dimidiata** Loew.

Figure 3.

Saucropus dimidiata Loew, Neue Beitr., viii, p. 75, 1861; Mon. N. A. Diptera, ii, p. 225, 1864.

Thorax and abdomen yellow, the former with the flattened space and sometimes a central line black, the latter with black bands; bristles and hairs of the front and middle coxæ all yellowish; front metatarsi about the same length as their tibiæ. Length 4 mm.

Male: Eyes almost touching on the middle of the face; face and palpi silvery white; proboscis and antennæ yellow, arista brownish; front and occiput black, thickly white pollenose, the pollen on the occiput, the flattened space before the scutellum, and the metanotum appears to be tinged with blue; orbital cilia whitish. Thorax yellow, reddish yellow and shining on the dorsum, white pollenose on the pleuræ, there is the usual small black spot on the pleuræ in front of the halters; the flattened space on the dorsum black, and a black central line extends from this to the front of the thorax between the acrostichal bristles, this line seems to be a variable character, in one of the specimens before me it is almost wanting; humeri yellowish white; metanotum black; scutellum yellow, lighter colored on the disk and somewhat shining. Abdomen yellow with rather narrow black bands on the second, third, and fourth segments, those on the third and fourth sometimes not very sharply defined; the hairs of the abdomen mostly yellowish, the marginal row of bristles on the first segment black and rather short; fourth segment produced on the venter on the posterior end; fifth segment higher than long, somewhat pointed in front on the dorsum, entirely yellow except the brown ventral sheath, and with rather long yellow hair. Hypopygium black or testaceous, polished, and rather small with yellowish appendages. Legs pale yellow; front and middle coxæ with all the hairs and bristles yellowish white; hind trochanters with a small black bristle; front tarsi more than twice the length of their tibiæ, and with a row of long hairs below; front metatarsi a little longer than their tibiæ; middle metatarsi about the same length as their tibiæ; hind tarsi a little shorter than their tibiæ, first joint a very little shorter than the second; all the tarsi infuscated from the tip of the first joint. Wings hyaline, very slightly tinged with grayish; the bend in the fourth vein rather sharp and at the middle of the last section; tip of the fourth vein before the apex of the wing; posterior cross-vein a little less than twice its length from the wing margin, measured on the fifth vein.

Female: A single female that I take to be the female of this species has black hairs and bristles on the middle coxæ, and black bristles and yellow hairs on the front coxæ; the front tarsi twice as long as their tibiæ, the metatarsi being as long as the tibiæ; middle metatarsi as long as their tibiæ; first and second joints of hind tarsi equal.

This seems to be a southern species, Dr. Loew reporting it from Florida and Washington, D. C.; the only specimens I have seen (one female and two males) were taken by Mr. Nathan Banks at Falls Church, Va., July 10th to Sept. 26th.

4 **Neurigona carbonifer** Loew.

Figure 4.

Saucropus carbonifer Loew, Diptera Americae Septentrionalis Indigena, ix, 84, 1869.

Thorax and abdomen yellow, the former with the flattened space in front of the scutellum black, the latter with black bands; hypopygium yellow; front tarsi with an oval tip. Length 4-5 mm.

Male: Face and palpi silvery white, the latter longer and narrower than in most species; face rather wide for a male, and with the sides nearly parallel; front and occiput black, thickly covered with white pollen; proboscis and antennæ yellow, the latter with the third joint small, arista brownish; orbital cilia and post-vertical bristles yellowish. Thorax reddish yellow, flattened space before the scutellum, a large spot on the pleuræ, another above and in front of the middle coxæ, and a small spot in front of the halters black; a dark line between the acrostichal bristles, and sometimes along the row of bristles on either side; humeri yellowish white; bristles of the dorsum well developed, a large yellow bristle on the pleuræ above the front coxæ; scutellum pale yellow, slightly darkened at base; metanotum black. Abdomen yellow more or less distinctly banded with black on the second and third segments; first and fifth segments with yellowish hairs, the large bristles on the hind margin of the first, and the hairs on the dorsum of the second, third, and fourth segments black; venter yellow with long, yellow hairs on the fourth segment, hypopygium, its appendages, and the sheath on the venter of the fifth segment yellow. Coxæ and legs pale yellow, all the hairs and bristles of the front coxæ whitish, sometimes the larger bristles brownish in certain lights; middle coxæ with a few black hairs and bristles in front near the tip; front tarsi twice as long as their tibiæ first joint three-fourths as long as their tibiæ, the fourth joint whitish and widened at the tip, fifth joint black, flattened, forming an oval tip to the tarsi; middle metatarsi about the same length as their tibiæ; first joint of hind tarsi shorter than second, wings hyaline; veins brown; last section of fourth vein very sharply bent forward near the middle, ending before the apex of the wing, rather close to the tip of third vein.

Female: Venation the same as in the male; front metatarsi about three-fourths as long as their tibiæ; front coxæ with yellow hairs and black bristles; the bands on the abdomen narrow but sharply defined; there are no black spots on the pleuræ as in the male except the usual one in front of the halters; and no central line on the dorsum; the flattened space before the scutellum seems to be black as in the male, but is so much injured by the pin that I cannot be sure.

Redescribed from eight males and one female, three of the males are from Prof. Aldrich's collection, two were taken at Battle Creek, Mich., and one at National Park, N. J.; this last was taken by Mr. V. A. E. Daecke; two males were in Mr. Nathan Banks' material, and were taken by him at Glencarlyn, Va.; and three were sent me by Prof. C. W. Johnson, and are from Buttonwoods, R. I., Hanover, N. H., and Cohasset, Mass.; the female is in the American Entomological Society's collection and was taken at Manayunk, Pa. The one from New Jersey was taken May 20th, the others were taken in June and July.

Note.—I have placed this single specimen as the female of this species as it agrees in all the principal characters with the male.

5 **Neurigona nitida** n. sp.

Figure 5.

Thorax and abdomen yellow, the former shining black on the dorsum, the latter with three wide black bands. Hypopygium black, hairs and bristles of the front coxæ whitish. Length, 4½ mm.

Male: Face very narrow, white; palpi white; proboscis yellow; antennæ yellow, arista brownish. Front and occiput black with white pollen; frontal and post-vertical bristles black; orbital cilia white. Mesonotum reddish-yellow along the lateral margins, black on most of the disk and very shining, with a greenish reflection. Pleuræ yellow with white pollen, humeri more whitish; flattened space before the scutellum with gray pollen; scutellum yellow with a black base. The pleuræ with a black spot in front of the halters, and another above the hind coxæ. Metanotum black, abdomen yellow with wide black bands on the dorsum of segments two, three and four, that on the second near the base and narrowed laterally, those at the base of the other two about equal width throughout; fifth dorsal segment produced anteriorly in a blunt, blackish point; the usual bilobed sheath on the venter black; hairs of the first four segments black, those of the fifth pale. Hypopygium not very large, shining black, basal part subquadrate, appendages pale yellow. Front coxæ with white hairs and bristles, middle ones with black hairs; front metatarsi as long as their tibiæ, with a row of long bristles on the bottom, continued on the next three joints; those on the metatarsi a little longer than the diameter of that joint; second and third joints fuscous, fourth and fifth a little lighter; middle metatarsi nearly as long as their tibiæ; hind tarsi with the second joint longer than the first; middle and hind tarsi infuscated from the base. Wings hyaline, tinged with brownish, darker on the front; fourth vein bent forward, ending not far from the tip of the third vein, and some distance front of the apex of the wing.

Female: Differs from the male in having only the central line between the acrostichal bristles and the flattened space before the scu-

tellum black, the central line is narrowed to a point anteriorly, hardly reaching the front of the mesonotum, the flattened space is thickly covered with white pollen; the front coxæ have pale hairs and black bristles; the front tarsi a little infuscated on the last four joints, middle ones fuscous from the tip of the first joint; abdomen with even black bands on the tergum of segments two to five.

Described from two males and one female in the collection of Prof. J. M., Aldrich taken in Polk Co., Wis., in July, by Mr. Baker; and one female in the National Museum collection taken at Franconia, N. H., by Mrs. Slosson.

6 **Neurigona tridens** n. sp.

Figure 6.

Thorax dark reddish yellow, with a large three pronged black mark on the dorsum; abdomen yellow with black bands. Length 3 1-3 mm.

Female: Face silvery white; antennæ yellow; arista yellowish brown; front and occiput black with white pollen; orbital cilia white. Dorsum of the thorax dark reddish yellow on the lateral and posterior edges, and the humeri; central portion largely black, the black extending to the front of the mesonotum, and on the posterior part forming three vittæ, the central one ending in the flattened space before the scutellum, this space being also black, and the lateral vittæ not quite reaching the scutellum; pleuræ partly black, dorsum somewhat shining, thinly pollenose, the pollen thicker on the flattened space; scutellum yellow; metanotum black, abdomen yellow with broad black bands at the base of the second to fifth segments, these bands occupy more than half of the segments on the center of the tergum, but narrow laterally; venter yellow; hairs and bristles of the abdomen black. Legs pale yellow; hairs and bristles of the front coxæ black; front metatarsi four-fifths as long as their tibiæ, the remaining four joints taken together but little longer than the first; front tarsi blackened from the tip of the first joint; hind tarsi shorter than their tibiæ, the second joint longer than the first, last four joints black, contrasting sharply with the pale yellow of the first joint, but the extreme tip of the first joint brown. Wings brownish hyaline; veins dark brown; fourth vein ends in the apex of the wing rather close to the tip of the third vein.

Described from one female in the collection of Prof. J. M. Aldrich, and taken on Mt. Constitution, Orcas, Idaho, July 7, 1905.

7 **Neurigona signifer** Aldrich.

Neurigona signifer Ald. Transactions of the Entomological Society of London, 1896, pt. 3, p. 337.

The following is a copy of the original description, as I have not seen this species.

"Male: Face very narrow, immediately under the antennæ is a triangular portion of yellow, below this there is only a narrow groove between the eyes to below the middle, from this point the face pro-

trudes as a narrow whitish wedge, slightly wider at the bottom; proboscis brownish; palpi yellow; front greenish-brown, a little dusted, converging below; antennæ yellow, third joint with a short point, arista yellow; inferior orbital cilia whitish; occiput green with white dust. Thorax dark yellow glabrous, with black bristles, acrostichal bristles small, in two rows, on each side of these in front is an area of small bristles, bounded by the humeri and the anterior margin. The flat bare disk is a beautiful greenish-blue color, which extends to the disk of the scutellum, sides and border of the scutellum yellow; two very large bristles between two very minute ones on the border; a very large bristle behind the root of the wing; pleuræ deep yellow, imperceptably dusted, a dark spot above middle coxæ; tegulæ cilia whitish. Abdomen slender, yellow, the segments beyond the second successively shorter, the second segment bears near its front margin an opaque black band, emarginate behind in the middle, and rounded at each end. It is about half as wide as the segment. The following segments have similar bands, less emarginate, and occupying more of the width of the segments, the fifth is wholly black across the dorsum. Like the others it is yellow along the ventral sides; hypopygium shining black, turned under, club-shaped, not much exserted, the appendages not distinct. All the coxæ yellow, front ones long with black hairs and mixed brownish-yellow bristles, middle ones with black hairs, hind ones with a single bristle on the outside; legs yellow, simple, the bristles small, tarsi a little infuscated towards the tip. Wings a little yellowish, fourth vein in its last segment only very gently curved, almost perfectly parallel with the third.

Female: Face narrow, strongly protruding below, yellow, and yellow pollenose, palpi larger than in the male; third joint of the antennæ small, exceedingly short, almost kidney shaped.

Length 3½ mm., wing 3 4/10 mm.

St. Vincent, 1500 feet altitude. Occurs also in Grenada."

Note.—*N. brasiliensis* Schin. is closely related to this species agreeing with it in coloration; it was described from a female, but it can be distinguished from *signifer* Ald. by its having a central line on the dorsum, extending from the flattened space before the scutellum about half way to the front of the thorax, this line is the same color as the flattened space; and by having the third and fourth veins much more convergent than in *signifer*.

I have seen two specimens which I refer to *brasiliensis*, one a male in the National Museum, and the other a female in the collection of Prof. J. M. Aldrich; the former is from Grenada, and the later from Vera Cruz.

8 **Neurigona maculata** n. sp.

Figure 8.

Mesonotum reddish yellow, with three black vittæ or spots; pleuræ with black spots; abdomen yellow with black bands; middle metatarsi with a row of long bent bristles below; hypopygium small, shining black. Length 4–5 mm.

Male: Face and palpi white; eyes narrowly separated at the center of the face; proboscis and antennæ yellow, arista brownish; front and occiput black, thickly covered with white pollen; orbital cilia whitish, post-vertical bristles yellowish. Mesonotum reddish-yellow with three black vittæ or spots, the central one subquadrate (in one of my specimens this spot is missing), lateral spots oval and quite variable in size; humeri yellowish white; pleuræ pale yellow with white pollen, and with a large black spot in the center, a long spot between the front and middle coxæ sometimes connected with the central spot, a small spot above the hind coxæ, and the usual small spot in front of the halters; scutellum yellow with the extreme base black; metanotum black, a little shining, and white pollenose. Abdomen yellow with three wide black bands, one near the base of the second segment, and one at the base of the third and fourth segments, these bands widest on the center of the dorsum; fifth segment with a narrow black dorsal line and sometimes a very narrow basal band; venter yellow; fifth segment without a ventral sheath. Hypopygium and its appendages shining black, polished, rather small, and with a few scattering pale hairs. Legs pale yellow; front coxæ with delicate yellowish hairs in front, and black bristles near the tip; front metatarsi about as long as their tibiæ, the fourth joint short, about as broad as long; middle metatarsi nearly as long as their tibiæ, and with a row of long bristles on the lower side, these bristles more or less bent backwards at tips; this row of bristles continued on the tibiæ but the bristles scattering and straight; hind tarsi with the first and second joints equal. Wings grayish hyaline, a little darker in front; last section of fourth vein bent forward a little from a little beyond the center, not very close to third at tip; tip of fourth vein a little before the apex of the wing.

Female: Agrees with the male in all but sexual characters, except that it has only short scattering bristles on the lower side of the middle metatarsi; and the fourth joint of the front tarsi are longer than in the male; in one specimen the lateral spots on the dorsum of the thorax are wanting.

Described from five males and ten females from Canada, N. H., Mass., N. Y., Pa., N. C., Mich., and Wis. I have taken them in the vicinity of Buffalo, N. Y., and at Toronto, and Kearney, Ont., from June 10 to July 9; Prof. J. M. Aldrich sent me specimens from Polk Co., Wis., taken in July, from Philadelphia, Pa., taken by Mr. V. A. E. Daecke, June 12, and from Battle Creek, Mich.; Mr. Nathan Banks sent specimens

from Sea Cliff, and Ithaca, N. Y.; Prof. C. W. Johnson sent specimens from Chester, Mass., taken August 4; Brookline, Mass., June 18; Hampton, N. H., July 10, taken by S. A. Shaw, and from Lake Toxaway, N. C., taken by Mrs. Slosson; the National Museum collection has a specimen taken at Mt. Washington, N. H., by Mrs. Slosson.

9 **Neurigona floridula** Wheeler.

Figure 9.

Neurigona floridula Wheeler, Proc. Cal. Acad. Sci. ii, p. 72, 1889.

Thorax and abdomen yellow; hypopygium with the first half yellow, last half black; front tarsi plain, with the fourth joint of front tarsi less than one-half as long as third; wings tinged with yellow. Length 5 mm.

Male: Face rather wide for a male, white; palpi white; proboscis yellow; front and occiput black, thickly covered with white pollen, thinner on the center of the front; antennæ yellow, third joint a little infuscated, arista brown; frontal bristles black, orbital cilia and postvertical bristles whitish yellow. Mesonotum yellow, shining; pleuræ paler, opaque and with a coat of white pollen, with a black line in front of the halters; metanotum and scutellum yellow, a little shining; outer hairs of the scutellum small but distinct. Abdomen yellow, darker on the third and fourth segments; third with a narrow dark band near the posterior end, continued across the venter (sometimes this band is indistinct); dorsum of the fourth segment with a poorly defined wide blackish band; fifth light yellow; venter yellow with a transverse row of long yellow hairs on the third segment; hairs on the second, third and fourth segments mostly black, those on the first and fifth yellow, the marginal row of bristles on the first segment black; hypopygium a short oval in outline, compressed laterally, the basal part yellow, last part black or testaceous, the yellow part nearly two-thirds of the whole. Legs light yellow; front coxæ with short yellow hairs on the whole of the front and with black bristles near the tip; middle coxæ with black hairs and bristles; front and middle metatarsi about the same length as their tibiæ; fourth joint of front tarsi less than one-half as long as third; second joint of hind tarsi distinctly longer than first; tegulæ, their cilia, and the halters light yellow. Wings hyaline, strongly tinged with yellow in front of fourth vein, third and fourth veins convergent, fourth vein ending in apex of the wing, not very close to the tip of third; veins yellowish; anal angle obsolete.

The following is a copy of Prof. Wheelers description of the female. I give it in full for the benefit of those who may wish to study the synonymy of this species.

"Female: Length 4½-5½ mm., length of wing 4¼-5 mm. Proboscis reddish yellow with pale hairs; palpi and face yellow, thickly covered with silvery white dust, the latter of the usual width for a female, and with the portion below the transverse suture receding; antennæ yellow,

third joint lacking; (I find it small and the arista brown) front and occiput black, thickly covered with silvery white dust; post-ocular cilia white; eyes green. Thorax, scutellum, and abdomen reddish yellow, covered with white dust, which is most abundant on the lateral portions of the thoracic dorsum and the pleuræ; prescutellar depression shallow; scutellum with two median long bristles and two feeble lateral bristles. Abdomen covered with short black hairs; pleuræ with a black spot below the root of the wing. Coxæ reddish yellow dusted like the pleuræ; anterior surface of the fore coxæ beset with short white hairs, and a few conspicuous black bristles near their proximal ends; similar bristles occur in a corresponding position in the middle coxæ; hind coxæ with a single bristle on the lateral surface, and a few bristles near the tip. Legs and metathoracic epimera light yellow; the femora very slender and covered with small black hairs; last joint of all the tarsi black; fore tarsi twice as long as the fore tibiæ; middle tarsi nearly twice as long as the middle tibiæ; hind tarsi scarcely as long as the hind tibiæ, hind metatarsi distinctly shorter than the succeeding joint. Wings scarcely narrowed towards the base, distinctly yellowish, and with yellow veins; apical segment of fourth vein rather sharply bent upwards near its middle, ending rather close to the tip of the third vein; posterior cross-vein about two and one-half times its length from the posterior margin of the wing, measured along the distal segment of the fifth vein. Halters and tegulæ yellow, the latter with yellow cilia."

In the above description Prof. Wheeler states that the wings are scarcely narrowed towards the base. I find in all the species that I have seen that where the wings of the male are narrowed at base so as to leave little or no anal angle that the wings of the females are normal, and have the anal angle prominent, as is the case with this species. Male described from three specimens, one in the collection of Prof. Aldrich, taken by Mr. Daecke, at Philadelphia, Pa.; one received from Mr. Daecke and taken by him at Perdix, Pa., on June 10; the other in the National Museum collection, and taken on Mt. Washington, N. H., by Mrs. Slosson. I have seen females from the following states: Me., N. H., Vt., N. J., N. Y., Pa., Md., Del., Va., N. C., Ohio, Mich., and Canada. Prof. Wheeler also mentions Illinois.

Note.—In Prof. Aldrich's Catalogue of North American Diptera, *floridula* is placed as the female of *carbonifer*, but after careful study of the material in my hands I prefer to place *floridula* as a distinct species, and place the male described above with it, as they agree in all essential characters, except those points which usually form the sexual distinction.

10 **Neurigona floridula** var. **infuscata** n. var.

Figure 10.

Thorax and abdomen yellow, the latter with more or less distinct bands; hypopygium black, more or less yellow on the first half; front tarsi plain, and with the fourth joint more than one-half as long as the third; tip of the wing infuscated. Length, $5\frac{1}{2}$ mm.

Male: Face rather wide for a male, somewhat narrowed in the middle, silvery white; antennæ yellow; front and occiput black, covered with white pollen; orbital cilia and post-vertical bristles yellowish white. Thorax yellow, shining on the dorsum; flattened space before the scutellum dull with yellowish pollen; pleuræ paler and covered with white pollen, a black line in front of the halters, also a black spot in front of the middle coxæ; metanotum yellow, more or less infuscated close to the abdomen; scutellum yellow, paler below. Abdomen yellow, the first segment paler and more or less infuscated at base; second and sometimes the third segment with a distinct black band at base; fourth segment more or less infuscated, but hardly banded; sometimes the third and fourth segments almost entirely yellow; venter yellow, with a transverse black line at hind margin of third segment, this line fringed with long yellowish hairs; hairs on the dorsum of the second, third, and fourth segments black, except on the lower edges where they are more yellowish. Hypopygium black, shining, and testaceous or yellowish on the first half. Legs pale yellow; front coxæ with yellow hairs on the front side, and black bristles near the tip; hairs and bristles of the middle coxæ black; a black bristle on each middle and hind trochanter; a few yellowish hair-like bristles at base of middle femora below; one or two yellowish bristles above front coxæ; front tarsi hardly twice as long as their tibiæ, the first joint about the same length as the remaining four joints together; fourth joint less than one-half as long as the third; fifth joint black; middle metatarsi the same length as their tibiæ; first joint of hind tarsi shorter than the second; middle and hind tarsi infuscated almost from the base. Wings hyaline, strongly tinged with brown along the front, and with a distinct cloud at tip; last section of fourth vein bent forward at the middle and ending in the apex of the wing, not far from the tip of the third vein; anal angle obsolete; veins yellowish brown to brown.

Female: Differs from the male in the form of the wings, the anal angle being well developed; wings a little less tinged with brown in front, and without the cloud at tip. Abdomen without distinct bands, but sometimes darkened in spots.

Described from thirteen males, which I took at Little Valley, N. Y., June 10, 1912; and twenty females from Pa., R. I., Mass., N. Y., N. J., Mich., and Wis.

This may be a distinct species, but I cannot find any structural character to separate it from *floridula*. Both sexes are a little larger and more robust than the specimens of *floridula*

that I have seen; the male has the tip of the wing infuscated, the hypopygium is darker in color, the pleuræ have a black spot above the middle coxæ, and the wing veins are darker. The female is difficult to separate from *floridula*, but they are a little more robust, and darker in color.

11 **Neurigona flava** n. sp.

Figure 11.

Yellow, with yellow pollen. Abdomen with lateral brown spots. Wings tinged with yellow. Length 4¼ mm.

Female: Face and palpi white; antennæ yellow, the first joint paler, arista brown; front and occiput black, thickly covered with yellowish-white pollen; frontal bristles black, orbital cilia and post-vertical bristles yellowish. Dorsum, scutellum, and metanotum yellow, evenly yellow pollinose, humeri and pleuræ whitish-yellow, and yellowish pollenose, a black line in front of the halters. Abdomen yellow, with narrow brown lateral spots on segments three and four; these spots are at the base of the segments and scarcely form bands; hairs of the abdomen mostly black. Legs pale yellow, tarsi scarcely darkened at tip, fore coxæ with yellow hairs and black bristles; second joint of hind tarsi longer than first; front and middle metatarsi three-fourths as long as their tibiæ Wings strongly tinged with yellow, all veins bright yellow; fourth vein ends in tip of the wing, a considerable distance from the tip of the third vein.

Described from one female in Prof. J. M. Aldrich's collection, and taken at Lewiston, Idaho, on June 17, 1902.

Note.—This species may be distinguished from *transversa* by the deeper yellow pollen of the dorsum being evenly distributed; in this species the acrostichal bristles are very poorly developed, while in *transversa* they are very conspicuous. In this, the second joint of the hind tarsi are distinctly longer than the first, the wings have a strong yellow tinge and the veins are bright yellow, all of which is different in *transversa*.

From *floridula* it differs by the dense yellow pollen of the dorsum, and the third and fourth veins being much further apart, the wings are also a brighter yellow, but this character is of little use unless the student has both species before him.

12 **Neurigona aldrichii,** n. sp.

Figure 12.

Thorax and abdomen yellow, the latter with black bands; hypopygium black and yellow; second joint of front tarsi shorter than the fourth, flattened, and widened at tip. Length 3–3½ mm.

Male: Face and palpi white; eyes contiguous; antennæ and proboscis yellow, arista brownish yellow; front and occiput dark grayish green with white pollen; orbital cilia whitish. Thorax yellow, shining;

humeri, pleuræ, scutellum, and the flattened space before paler; scutellum with a blackish spot at base; pleuræ with a black line in front of the halters, this line sometimes broken into two spots; metanotum black. Abdomen yellow with narrow black bands near the base of segments two, three, and four, the first sometimes infuscated at base; hairs of the abdomen mostly pale; hypopygium nearly as long as segments four and five, but not very thick, first half yellow, last half black or testaceous. Legs pale yellow; front coxæ with a few yellow bristles near the tip; middle coxæ with black hairs and bristles; front metatarsi hardly as long as their tibiæ, second joint shorter than fourth, and with the apex widened and extended in the form of a short spur on top, somewhat infuscated at tip; third joint a little longer than fourth, and both with a row of short bristles below, these bristles hardly as long as the diameter of the joint; middle metatarsi about four-fifths as long as their tibiæ, fourth joint slightly flattened, fourth and fifth joints fuscous; apical half of middle tibiæ brown; hind tarsi with the first joint a little shorter than the second, and becoming fuscous from the tip of the first joint. Wings grayish hyaline; fourth vein bent forward from the center of the last section, the tip quite close to the tip of the third vein, and some distance in front of the apex of the wing.

Female: Differs from the male in having the face quite wide; the abdomen with the hind margins of segments two and three, and sometimes the bases of all the segments infuscated; the hairs and bristles of the front coxæ black; all the tarsi normal and scarcely infuscated; metanotum yellow.

Described from two males and five females, taken by Prof. J. M. Aldrich, at Lawrence, Kansas, on June 8th.

13 **Neurigona transversa** n. sp.

Figure 13.

Thorax reddish yellow, with three pollenose vittæ; abdomen yellow, with the hind margins of the segments pale; a narrow black line above the pronotum. Length 5–5½ mm.

Female: Face wide, with the sides parallel; face and palpi whitish; antennæ deep yellow, first joint paler; palpi with yellow bristles at tip; front and occiput black, thickly whitish pollenose; frontal bristles brownish yellow, orbital cilia rather long and whitish. Dorsum of the thorax reddish yellow, with three vittæ formed with yellowish pollen, the narrow central one between the acrostichal bristles has the pollen more dense, the lateral vittæ not so sharply defined. There is a bare spot above the root of the wing in each of these vittæ; metanotum, scutellum, and the flattened space in front thickly covered with yellowish pollen, which is thinner at the base of the scutellum, the pollen on the lower part of the pleuræ more whitish; the usual black line in front of the halters; a yellow bristle above the front coxæ; front of the mesonotum with a black transverse line which is almost interrupted in the middle. Abdomen reddish yellow, slightly infuscated, and with distinct yellowish white bands on the hind margins of the segments, that

on the fifth not as distinct as on the other segments, and that on the first widest; halters, tegulæ, and their long cilia yellowish white. Hairs and bristles of the coxæ black, except the short hairs on the front coxæ which are yellow and easily overlooked; the front and middle metatarsi about three-fourths as long as their tibiæ; tips of the tarsi infuscated; first and second joints of the hind tarsi equal. Wings grayish hyaline; fourth vein ends in the apex of the wing, the tip widely separated from the tip of the third vein; veins brown.

Described from two females taken at Moro Lake, Cal., July 23, 1911, by Prof. J. M. Aldrich.

14 **Neurigona disjuncta** n. sp.

Figure 14.

Thorax and abdomen yellow, the latter sometimes with black bands; hypopygium yellow, appendages testaceous; front tarsi plane, with the fourth joint nearly two-thirds as long as the third; tip of the wing infuscated. Length, 4½-6 mm.

Male: Face rather wide for a male, and with the sides nearly parallel, only a very little wider below; face and palpi with silvery white pollen; antennæ yellow, arista brown; front and occiput black, thickly white pollenose; orbital cilia and post-vertical bristles white. Thorax yellow, somewhat shining on the dorsum, but dulled with white pollen; humeri and pleuræ pale yellow, and covered with white pollen; pleuræ with the usual black spot in front of the halters; scutellum and metanotum yellow; the flattened space before the scutellum sometimes slightly infuscated. Abdomen yellow with black or brown lateral spots on the dorsum of the second, third, and fourth segments, these spots sometimes united into bands on the third and fourth segments; venter yellow, with a black transverse ridge on the third segment. This ridge is ciliate with long whitish hairs, hairs on the venter yellowish white, those on the tergum mostly black; fifth segment short, and with the ventral sheath black and polished. Legs pale yellow; front coxæ with short yellow hairs on the front side, and large black bristles near the tip; middle coxæ with black hairs and bristles near the tip; front and middle metatarsi about as long as their tibiæ; front tarsi infuscated from the extreme tip of the first joint; fourth joint of front tarsi nearly two-thirds as long as third; middle and hind tarsi growing darker from the base to the tip, second joint of hind tarsi longer than the first. Wings grayish hyaline, with the apex more or less infuscated; third and fourth veins widely separated at tips; fourth vein ending slightly back of the apex of the wing.

Female: Agrees with the male in most characters, except the sexual difference, but the abdomen may lack the lateral spots; and the wings are not infuscated at apex, but somewhat tinged with yellow along the front.

Described from five males, and nine females, from Vt., N. Y., and Canada. I have taken them from the vicinity of Buffalo, N. Y., and also at Toronto, and Ridgeway, Ont.;

Prof. C. W. Johnson sent me one male, taken at Mt. Ascutney, July 11, and three females taken at Norwich, July 9; both places are in Vermont. The specimens that I took were found from June 6 to July 4.

Note.—The male of this species in general appearance resembles the male of *floridula* var. *infuscata*, but can be readily separated by the difference in venation and the greater relative length of the fourth joint of the front tarsi to the third.

I have in my collection seventeen females that seem to be a variety of this species, they were taken at East Aurora, N. Y., June 15th and 22d, 1912. They are somewhat smaller, (3½–4 mm.), and paler; some of them have sharply defined black bands on the abdomen; the third and fourth veins approach each other a very little more than in the typical forms, the fourth vein ending exactly in the apex of the wing.

There are two females in Prof. Aldrich's collection that seem to be the same as the above variety. They were taken at Battle Creek, Mich., and Ithaca, N. Y.

15 **Neurigona viridis** n. sp.

Figure 15.

Thorax bright metallic green, sometimes coppery on the dorsum; abdomen mostly dark metallic green, with the first two segments partly yellow; hypopygium black, polished; front tarsi with the fourth and fifth joints a little flattened; wings with the third and fourth veins nearly parallel. Length, 3½–4 mm.

Male: Eyes contiguous on the center of the face for some distance, leaving only a small triangle above and below, face and palpi silvery white; palpi rather large and with yellowish bristles at tip; proboscis yellow; front and occiput dark metallic green, with white pollen; antennæ deep yellow, the third joint a little brownish at tip, arista brown; frontal bristles black, orbital cilia and post-vertical bristles whitish. Thoracic dorsum bright shining green, sometimes with coppery reflections, and a little dulled with whitish pollen; pleuræ dark greenish, the ground color partly concealed by grayish white pollen; scutellum bright green on the disk, yellow below and usually on the lateral angles; metanotum darker green with white pollen. Abdomen with the first two segments yellow, a large dark greenish spot on the dorsum of the second, which sometimes covers most of it; the following segments dark metallic green or greenish black, with the posterior edges yellow and thickly covered with white pollen, in some specimens these edges very narrow; hairs of the abdomen mostly pale, and those on the hind margins of the segments rather long; hypopygium rather large, black, polished, and with a pair of long whitish appendages on the posterior margin. Legs pale yellowish; the hairs and bristles of the front coxæ

whitish, the bristles more brownish in certain lights; middle coxæ with black hairs and bristles; front and middle metatarsi shorter than their tibiæ; *fourth joint of front tarsi flattened, fifth also slightly flattened;* second joint of hind tarsi about one and one-third times as long as the first; tegulæ, their cilia, and the halters pale yellowish. Wings grayish hyaline, last section of fourth vein only feebly bent and slightly approaching the third, fourth vein ends in the apex of the wing; veins dark brown, yellow at the root of the wing.

Female: Like the male in general characters but the front tarsi are plain, the face narrow, with its sides parallel, the hairs of the front coxæ black, and the abdomen with more yellow.

Described from four males and six females from N. H., N. Y., and Va. I took the four males and two females at South Wales, Erie Co., N. Y., July 9, 1911; two of the females are from Mr. Nathan Banks, and were taken at Glencarlyn, Va., July 23; two females are in the National Museum collection, one from the White Mountains, N. H., and the other was reared by Mr. James Angus from larvæ feeding in rotten wood of hickory, at West Farms, N. Y., the imago issued May 9, 1884.

16 **Neurigona decora** Aldrich.

Neurigona decora Aldrich, Kansas University Science Bulletin, Vol. 1, p. 83, 1902.

"Male: Eyes barely contiguous on the upper part of the face, slightly separated above and below; front broad, opaque, dark; antennæ small, red, the tip of the third joint brownish; orbital cilia pale. Thorax bright, shining blue, the concavity before the scutellum more bronze; pleuræ green, with thin dust, and the hind margin yellow; tegular cilia yellowish. Abdomen rather short, the first two joints yellow, the rest dark green, shining above. Hypopygium rather prominent, exserted, yellow. Coxæ yellow, the middle ones dark at base; remainder of legs and tarsi yellow; a slender hair on the outer side of the second joint of fore tarsus at its apex. Wings a little yellowish; the fourth vein converges toward the third at the end, terminating before the apex of the wing.

"Female: Face linear; eyes not contiguous.

"Length 2.8 to 3 mm. Two males, two females. One of the latter is from St. Vincent, but was not mentioned in the previous paper."

I have copied the above from Prof. Aldrich's paper on the Dolichopodidæ of Grenada.

17 **Neurigona arcuata** n. sp.

Figure 17.

Thorax greenish; abdomen yellow, with black bands; hypopygium small black; wings with the costa much arcuated, and with a brown cloud along the front; front tarsi with the fourth and fifth joints black, the fifth joint nearly at right angles to the fourth. Length of male, $3^3/_4$ mm.; of female, $3^1/_2$–$3^3/_4$ mm.

Male: Face silvery white, not very narrow for a male, but somewhat narrowed in the middle; proboscis yellow; front and occiput greenish, thickly covered with white pollen; frontal bristles black, orbital cilia whitish; antennæ yellow, arista brownish. Mesonotum metallic green, somewhat shining but dulled with grayish pollen, the narrow space between the acrostichal bristles more shining and without pollen; humeri and posterior angles of the dorsum yellow; pleuræ black, thickly covered with white pollen; scutellum yellow; metanotum black, a little shining, and with white pollen. Abdomen yellow, dorsum of segments two to four with wide black bands; the fifth segment has a narrow black band; hairs of the abdomen mostly yellow, including the long bristles on the hind margin of the first segment; hypopygium small, black or testaceous, polished, appendages lighter testaceous, or sordid yellow. Legs pale yellow, front coxæ bare with a few yellow bristles near the tip; middle coxæ with black hairs and bristles; front femora with a few long yellow hairs near the tip on the outside; fourth joint of front tarsi not much more than one-half as long as third, shorter than fifth, and with a few long black hairs at tip, fifth joint and most of fourth black, fifth joint nearly at right angles to fourth; front metatarsi fully three-fourths as long as their tibiæ; middle tarsi with the second, third, and fourth joints slightly flattened, becoming black from the middle of the second joint, and with the metatarsi nearly as long as their tibiæ; middle tibiæ more or less infuscated in the center; first and second joints of the hind tarsi about equal. Tegulæ and their cilia pale yellow. Wings with the costa much arcuated; posterior margin indented at the apex of the fifth vein; third vein curved backwards towards the fourth; last section of the fourth vein curved forwards from a little beyond the middle in such a manner as to be nearly parallel with the third at tip; a brown cloud along the front of the wing, from about the tip of the first vein to the tip of the third, fading out back of third vein, and widest in the middle; veins brown, yellow at the base of the wing.

Female: Agrees with the male except in the following points; all the tarsi become fuscous from the middle of the second joint; front femora have no long hairs at tip; wings with the costa less arcuated, and without distinct cloud, but the front of the wing is slightly tinged with yellowish brown; the middle tarsi slightly flattened as in the male but less so; front tarsi plain; second joint of the hind tarsi longer than the first.

Described from five specimens taken by me at Kearney, Ont., July 3, 1909; and many specimens taken in the vicinity of Buffalo, N. Y., June 6th to July 4th.

18 **Neurigona deformis** n. sp.

Figure 18.

Thorax black; abdomen yellow with black bands; hypopygium black, small; three joints of the front tarsi flattened; wings with the costa and third vein much arcuated, and with a brown cloud along the front towards the tip. Length of male 6–6½ mm., of female 5½ mm.

Male: Face not very narrow for a male, but narrowest in the center, and silvery white; front and occiput black, covered with white pollen, which is thickest on the front and upper part of the occiput; antennæ yellow, the rather long arista brownish; frontal bristles black; orbital cilia and post-vertical bristles yellowish. Thorax black, rather shining on the dorsum, thinly dusted with white pollen, this pollen much thicker along the front, on the sides, and between the acrostichal bristles; the pollen on the flattened space before the scutellum thick and somewhat greenish; pleuræ covered with white pollen, which almost conceals the ground color; humeri, posterior angles of the dorsum, space between the front coxæ, and metathoracic epimera yellow; scutellum black on the disk, yellow beneath, which color extends somewhat onto the edge of the disk; metanotum black with white pollen. Abdomen yellow; second to fifth segments with black bands at base, those on the second and third segments widest on the center of the tergum, narrowing to a point on the lateral sides; hairs on the dorsum of the second and third segments mostly black, those on the rest of the abdomen and the long bristles on the margin of the first segment yellow; hypopygium black, polished, and with its appendages more or less testaceous; sheath on the venter of the fifth segment corrugated, and opaque black. Legs long and slender, pale yellow; front coxæ with minute yellow hairs on the front, and several yellow and one or two black bristles near the tip; middle coxæ with a few black hairs and bristles near the tip; front femora with about ten long yellow hairs on the outside near the tip; middle femora nearly bare except near the tip; front metatarsi about the length of their tibiæ; second, third, and fourth joints of front tarsi flattened, bare on the sides, ciliate with black hairs on the edges, the longer hairs on the top edge longer than the width of the third joint, those on the lower edge very short, last two joints of front tarsi infuscated; middle metatarsi about equal to their tibiæ in length; middle trochanters with a black bristle; first and second joints of hind tarsi nearly equal; middle and hind tarsi black; hind tibiæ infuscated. Halters, tegulæ, and their cilia pale yellow. Wings narrowed at the base, and with the costa much arcuated, the swell starting just before the middle; hind margin indented at the tip of the fifth and sixth veins; third vein much arcuated; last section of fourth vein nearly in a straight line with the basal part; wings hyaline, with a brownish cloud along the costa, beginning at the same point as the swell and extending to the tip of the fourth vein, fading out behind; a narrow faint cloud may be traced along the fifth, and last section of the fourth vein; veins pale yellow at the base of the wing, becoming brown on the disk.

Female: Wings with the costa nearly straight, the cloud less distinct than in the male, the whole wing being tinted with brownish in front of the third vein, and slightly clouded along the fifth vein; front tarsi plain, otherwise as in the male.

Described from four males and six females, from western N. Y. and Ont. I took the males and five females near Buffalo, N. Y., and one female at Kearney, Ont., July 8th; those taken near Buffalo were captured between June 6th and 15th.

Note.—This species is closely related to arcuata, but may easily be separated by its size, (this being the largest species taken so far in North America) the form of the front tarsi, and the wings, the latter being almost deformed.

19 **Neurigona tenuis** Loew.

Figure 19.

Saucropus tenuis Loew, Mon. N. A. Diptera ii, p. 228, 1864. Described from the female. The male was described by Prof. Wheeler in the Proc. Cal. Acad. Sci., ii, p. 73, 1899.

Mesonotum green; abdomen yellow, with black bands; hypopygium black, large; front tarsi about the same length as their tibiæ and with an oval tip. Length 3½–4 mm.

Male: Face and palpi white; eyes contiguous at the center of the face; proboscis yellow; front and occiput greenish gray, sometimes quite dark, thickly covered with white pollen; frontal bristles black, orbital cilia and post-vertical bristles pale yellow; antennæ yellow, the third joint sometimes brownish, arista brown. Dorsum of the thorax light verdigris-green, shining, dulled with thick grayish pollen, that on the flattened space before the scutellum a little yellowish; humeri and more or less of the lateral edges yellow; pleuræ greenish gray, with more or less yellow below, in some specimens nearly all yellow, covered with white pollen; scutellum green on the disk, with a rather wide margin of yellow; metanotum greenish gray, becoming dark brown in some individuals, white pollenose. Abdomen yellow with wide black bands on segments two, three, and four; those on the second and third narrowed laterally so as to form nearly triangular spots; fifth mostly or entirely black; first more or less brown on the dorsum; venter yellow on the basal segments, more brown or blackish toward the posterior end; hairs of the abdomen mostly black, with more pale hairs posteriorly, on the fifth segment they are altogether pale; those on the ventral surface of the fourth and hind part of third long; hypopygium black, basal part somewhat shining but dulled with white pollen, apical part, and appendages shining, polished. Legs pale yellow; front coxæ long and slender, with minute scattering hairs on the front side, and a few yellow bristles near the tip; middle coxæ with a very few black hairs or bristles near the tip, and a few yellow hairs at tip inside, these hairs curled inwards; hind coxæ usually blackened a little at tip on the inside; middle and hind femora with a few bristles on the inside near the base, those on the middle ones black, on the hind ones yellow; front meta-

tarsi about three-fourths as long as their tibiæ, and about one and one-fourth times as long as the remaining joints together; second and third nearly equal; fourth and fifth fringed on each side with long black hairs, which form a flat oval tip to the tarsi, this tip a little longer than wide; fourth joint except base, and fifth black; first joint of hind tarsi a very little longer than the second; middle metatarsi about three-fourths as long as their tibiæ. Tegulaæ, their cilia, and the halters pale yellow, the latter with a brown dot on one side at the base of the knob. Wings grayish hyaline; third vein slightly bent backward at tip; fourth vein bent forward from just before the middle of the last section, but the tip not very close to the tip of the third.

Female: Agrees with the male except that the front tarsi are plane, with the metatarsi a little shorter than their tibiæ, and more than twice as long as second joint; first and second joints of hind tarsi about equal; the mesonotum often nearly all yellow, except the flattened space before the scutellum.

Redescribed from many specimens taken in the vicinity of Buffalo, N. Y. This is the most abundant species of Neurigona around Buffalo, I have taken nearly one hundred specimens the past summer, the first on July 9th, and the latest on September 8th; the only other specimen I have seen is a male form Mt. Tom, Mass., taken July 14th, and sent to me by Prof. C. W. Johnson. Loew's Mon. gives Middle States as the habitat.

Note.—Prof. Wheeler in his description of the male of *tenuis* mentions a row of hook-like spines along the lower surface of the front tibiæ, also curved spines on the front matatarsi; I cannot detect these in our eastern specimens, although there is a row of very minute bristles or stout hairs on the lower surface of the front tibiæ that I have not mentioned in the description I have given above, because they are so easily overlooked that they are of little value in separating the species, but in the closely related western species that I am describing under the name of *pectoralis* these bristles are a conspicuous character. The males of these two species are so nearly alike in general appearance that he may have confused them. They may be separated by the front tarsi of *tenuis* being nearly as long as their tibiæ, while in *pectoralis* the tarsi are much shorter than their tibiæ; in *tenuis* also the front legs are infuscated from, or before the middle of the tibiæ, in *pectoralis* there is no infuscation of the front legs except the enlarged tip of the tarsi which is black; *pectoralis* has the first and second joints of the hind tarsi equal, while in *tenuis* the first joint is a little the longest; the middle coxæ of *pectoralis* have yellow bristles which are not found in *tenuis*.

20 **Neurigona pectoralis** n. sp.

Figure 20.

Dorsum of the thorax metallic green; abdomen yellow with black bands; front tarsi much shorter than their tibiæ and with the last two joints flattened and fringed forming an oval tip; hypopygium black, rather large. Length 4 mm.

Male: Eyes very narrowly separated; face and palpi covered with white pollen; proboscis yellow; front and occiput light metallic green, the front thinly and the occiput more thickly covered with white pollen; antennæ yellow, arista yellowish brown; frontal bristles black, orbital cilia and post-vertical bristles whitish. Dorsum of the thorax light verdigris green, with yellowish pollen; pleuræ black with whitish pollen; humeri yellowish; scutellum yellow, with the base dark metallic greenish blue; metanotum black, with white pollen. Abdomen yellow, first segment more or less infuscated, second and third segments with black bands, which are widest on the center of the dorsum, and are narrowed laterally, hardly reaching the lower sides of the abdomen; fourth segment with only the hind margin yellow, fifth entirely black except a narrow white hind margin, interrupted on the center of the dorsum, and reaching about half way to the lateral sides; hairs of the abdomen mostly black on the dorsum, those on the lower part of the sides pale. Hypopygium black, rather large, rounded behind, the first half but little shining, appendages black or testaceous. Legs pale yellow; front and middle coxæ with only yellowish hairs and bristles on the front side; front pair rather long, middle and hind coxæ slightly darkened on the outside; front tibiæ about one and one-fourth times as long as their femora, and the front tarsi hardly as long as their femora; metatarsi a little longer than the four remaining joints together, second and third joints nearly equal and very slightly flattened, fourth and fifth black, flattened and fringed on each side with black hairs, forming a nearly round tip to the tarsi; front tibiæ and metatarsi with a row of small, hook-like bristles below; middle femora with a few black bristles near the base below; middle metatarsi about four-fifths as long as their tibiæ; first and second joints of the hind tarsi of nearly equal length, hind tarsi shorter than their tibiæ; halters, tegulæ, and their cilia pale yellow. Wings grayish hyaline, fourth vein ending in the apex of the wing; tips of the third and fourth veins quite widely separated.

Female: Agrees with the male, except that the hairs and bristles on the front of the middle coxæ are all black; the middle metatarsi are hardly three-fourths as long as their tibiæ, and the front tibiæ are about the same length as their femora and much shorter than their tarsi which are plane, and have the last joint blackened.

Described from two males and two females from N. M. in the National Museum collection, the two males and one female were taken by H. S. Barber, at Las Vegas, N. M., Aug. 7th, 9th and 13th; and the other female was taken by Townsend on the White Mountains, N. M., at 6500 feet altitude.

Note.—Under *tenuis* I have given the characters that separate the males of these two species; the females of these species can be distinguished from those of *tenuis* in having only the humeri yellow, the pleuræ being altogether black, and the dorsum dull greenish, while in *tenuis* there is more or less yellow on the dorsum and pleuræ.

21 **Neurigona æstiva** n. sp.

Figure 21.

Thorax blackish; abdomen yellow with black bands; hypopygium black with the upper part more or less yellow; front tarsi plane. Length 5½ mm.

Male: Face narrow, of nearly equal width throughout, face and palpi silvery white; proboscis and antennæ yellow, the latter with the third joint very small; arista brown; front and occiput blackish, but the ground color concealed by white pollen; orbital cilia whitish; postvertical bristles yellow. Thorax and metanotum blackish with white pollen, shining on the dorsum, pollen thickest on the pleuræ and the flattened space before the scutellum; humeri, a large spot at the insertion of the wings, and the scutellum except the base yellow; metathoracic epimera yellowish white; most of the bristles of the dorsum small and weak, the acrostichal bristles can hardly be traced in some individuals, but in others they are distinct. Abdomen yellow, the first segment more whitish; second segment with a black band near the base; third with a black band at the base; fourth black at base getting paler posteriorly; fifth segment dusky yellow, with the ventral sheath large and black; hairs of the abdomen and the bristles on the hind margin of the first segment yellow, those on the lower part of the fourth segment long; hypopygium mostly black or testaceous, shining, sometimes the first half partly yellowish. Legs yellowish white; hind femora more yellowish; hairs and bristles of the front coxæ all whitish, those of the middle coxæ black; front tarsi more than twice as long as their tibiæ, their metatarsi hardly as long as the tibiæ, and about equal to the second and third joints taken together; middle metatarsi four-fifths as long as their tibiæ; second joint of the hind tarsi longer than the first; all the tarsi slightly darker towards the tip. Wings hyaline, slightly tinged with yellowish along the front; third and fourth veins quite widely separated at the tips; fourth vein ending in the apex of the wing.

Described from three males from N. Y., Md., and Vt. I took the type specimen at Lancaster, N. Y., June 2, 1912; Prof. C. W. Johnson has sent me one which was taken at Norwich, Vt., July 7, 1908; and there is one in the National Museum collection taken on Plummers Island, Md., May 11, 1905, by Mr. Schwarz.

22 **Neurigona bivittata** n. sp.

Figure 22.

Thorax dark reddish yellow, almost brown, with thick gray pollen, and two brown vittæ. Abdomen yellow banded with black. Length 5 mm.

Female: Face broad, whitish pollenose, the yellow ground color showing through in the specimens before me, especially below the suture, antennæ with the first two joints pale yellow, the third more orange yellow, arista brown; front and occiput black, thickly white pollenose; orbital cilia whitish. Dorsum of the thorax dark reddish yellow, almost brown, and somewhat livid, but so thickly covered with gray pollen as to hide the ground color in unrubbed specimens, humeri pale yellow, there are two brown vittæ running from the front of the mesonotum to the flattened space before the scutellum. They are just outside of the acrostichal bristles, leaving the space between these bristles gray pollenose; these vittæ are wider posteriorly and not so sharply defined; pleuræ blackish with a reddish or livid tint, and thickly covered with white pollen; scutellum pale yellow; metanotum black with white pollen. Abdomen yellow with black bands at the base of second to fifth segments, these bands narrowed laterally, and emarginate at the center of the dorsum; venter yellow; hairs of the abdomen black; the long bristles on the first segment have a yellowish color in some lights. Legs pale yellow; front coxæ with very short hairs on the front side, which appear dark colored, and with one yellow and several brown bristles near the tip, the brown bristles having more or less of a yellow color in certain lights; middle coxæ with black hairs and bristles which are more abundant than in some species; front femora, tibiæ, and metatarsi about equal in length, the last four joints of the front tarsi together about the same length as the metatarsi; middle metatarsi shorter than their tibiæ; hind tarsi about equal to their tibiæ in length, the second joint distinctly longer than the first; last joint of all the tarsi slightly infuscated. There are the usual whitish bristles above the front coxæ. Wings grayish hyaline; veins yellowish brown; anal angle not prominent; tips of the third and fourth veins well separated, the fourth ending in the tip of the wing. Halters short, with the knob large.

Described from two females. The type specimen is labeled Colorado; the other is from Bear Lake, B. C., and was taken by R. P. Currie, July 20, 1903; both of these specimens are in the National Museum collection.

23 **Neurigona tarsalis** n. sp.

Figure 23.

Thorax black; abdomen yellow with three black bands; hypopygium yellow and black; third joint of front tarsi pure white, fourth and fifth joints black and flattened. Length 4½ mm.

Male: Face narrow in the center, a little wider above and below; face and palpi silvery white; proboscis and antennæ yellow, arista brown; front and occiput black, thickly covered with white pollen; orbital cilia

and post-vertical bristles yellowish. Dorsum of the thorax black, and thickly covered with white pollen, which generally forms two obscure narrow stripes; pleuræ black, covered with white pollen; prothorax, humeri, and metathoracic epimera yellowish white; scutellum pale yellow, black at base; metanotum black. Abdomen yellow, with the first segment and the posterior edges of the second, third, and fourth, and the venter paler; second, third, and fourth segments with wide black bands at base, that on the second narrowed laterally; fifth segment yellow with a polished black sheath on the venter; third segment with a black transverse line on the venter, this line near the middle of the segment and fringed with long whitish hairs; hairs of the abdomen mostly pale; the long bristles on the hind margin of the first segment black; hypopygium rather large, basal half yellow, the remaining part black and polished. Legs pale yellow; front coxæ with delicate pale hairs on the front side, and black bristles near the tip; middle coxæ with black hairs and bristles; middle trochanters with a black bristle below, and a black spot above; front metatarsi a little shorter than their tibiæ, the third joint as long as the fourth and fifth together, fourth nearly twice as long as fifth, third a little enlarged, snow white, and with white hairs; fourth and fifth black, flattened, and fringed with black hairs; middle metatarsi about the length of their tibiæ; second joint of hind tarsi a little longer than the first. Wings hyaline; tips of the third and fourth veins not very close together.

Female: Differs from the male in having the face quite wide, the front tarsi plane, middle trochanters without the black spot, fifth segment of the abdomen with a black band, wings tinted with yellowish along the front and the dorsum of the thorax more greenish.

Described from twelve males and twelve females, from N. Y., Pa., and Mich. I have taken sixteen specimens at East Aurora, Erie Co., N. Y., from June 11–15. Mr. Nathan Banks took one at Sea Cliff, N. Y. Prof. J. M. Aldrich sent me specimens from Battle Creek, Mich., and Pa.

24 **Neurigona lienosa** Wheeler.

Neurigona lienosa Wheeler, Proc. Cal. Acad. Sci. 3d series, 2, p. 72, 1899.

Length 4¼ mm., wing 3¾ mm.

"Proboscis yellow; palpi and face yellow, covered with silvery white dust, the latter of the usual breadth for a female; antennæ yellow, the small third joint with a blunt point, and covered with dark pubescence; arista distinctly pubescent; front and occiput metallic green, thickly covered with white dust; postocular cilia snow white. Thorax dull metallic green, the ground color almost hidden under a thick coating of brown dust; dorsal bristles prominent along the interior border of the thorax; scutellum slightly lighter metallic green, but also with a covering of dust, the scutellum bears two strong mesial, and two weak lateral bristles; first abdominal segment dark brown, succeeding segments black, dusted with white, posterior edges of second, third, and fourth segments, and venter yellow, ovipositor yellow at the base, tip

black, with delicate hairs; pleuræ blackish metallic green, thickly covered with white dust; metathoracic epimera dark brown. Coxæ yellow, fore and middle pairs with prominent black bristles on their anterior surface near their tips, hairs on upper portion of fore coxæ delicate and pale, hind coxæ with a single black bristle on its outer surface. Legs pale yellow, with black hairs, tarsi infuscated towards their tips, fore tarsi scarcely twice as long as the fore tibiæ, middle ones one and one-third times as long as the middle tibiæ, hind tarsi scarcely as long as the hind tibiæ, hind metatarsi distinctly shorter than the succeeding joint. Wings grayish hyaline with a yellowish tinge, broader in the middle, slightly narrowed towards the base; distal segment of fourth vein moderately bent forwards near its middle and ending not very close to the third vein; distal segment of fifth vein nearly two and one-half times as long as the posterior cross-vein. Halters and tegulæ dark brown, the latter with pale cilia."

I have not seen this species and have copied this from Prof. Wheeler's description, which was made from a single female specimen taken sweeping in pine woods at Monterey, Cal., July 22, 1896.

25 **Neurigona lateralis** Say.

Figure 25

Medeterus lateralis Say, Proc. Acad. Nat. Sci. Phila., Vol. vi, p. 169, 1829; Compl. Works, ii, p. 362.

Saucropus superbiens Loew, Mon. N. A. Diptera, ii, p. 227, 1864; Neue Beitr., vol. viii, p. 76, 1861.

Dactylongia gracilipes Aldrich, Kans. Univ. Quat., vol. ii, p. 151, 1894.

Thorax verdigris green; abdomen yellow with more or less brilliant metallic green; hypopygium yellow; front metatarsi longer than their tibiæ remaining joints very short; first joint of hind tarsi longer than second. Length of male 2–3 mm., female $2\frac{1}{2}$–$3\frac{1}{2}$ mm.

Male: Face narrow, silvery white, its sides nearly parallel; palpi and proboscis yellow; antennæ yellow, third joint a little infuscated, arista dark brown; front blackish, occiput greenish, both thickly covered with white pollen; frontal bristles black, orbital cilia whitish. Thorax dark verdigris green, somewhat coppery on the sides, grayish pollenose, except a narrow central line between the acrostichal bristles; scutellum more blue green, thickly gray pollenose; pleuræ and metanotum greenish black with whitish pollen; metathoracic epimera yellow. Abdomen yellow on the venter and lateral margins, generally the dorsum of the first segment more or less yellow, fifth yellow on the hind margin, and usually some of the incisures yellow, the rest brilliant metallic green, or blue green, rarely coppery, sometimes the green reduced to lateral spots, in one female before me there is scarcely a trace of green, but four lateral coppery spots; hairs of the abdomen pale; hypopygium rounded, yellow, with whitish appendages. Legs pale yellow; all the fifth tarsal joints black; front coxæ with long delicate yellowish hairs on the front, and a few yellowish bristles near the tip, these bristles blackish in certain lights; middle coxæ nearly bare; front metatarsi longer than

their tibiæ, remaining four joints together about one-fifth, or one sixth as long as the first, third and fourth not much longer than broad, second about the length of the two following, the third with a long hair at tip; middle metatarsi about as long as their tibiæ; first joint of hind tarsi longer than the second. Wings hyaline, little tinged with grayish; third vein only slightly curved at tip, last section of fourth vein approaching third from the cross-vein slightly sinuous, the tip not far from the tip of third, ending in front of the apex of the wing.

Female: Front tarsi normal, with the first joint about three-fourths as long as their tibiæ, front coxæ with yellow hairs and black bristles; first and second joints of hind tarsi about equal; otherwise as in the male.

Redescribed from many specimens. Ont., Que., N. H., Mass., Fla., Ind., Mich., Ill., S. D., and Washington, D. C.; taken during June, July, and September.

Note.—Dr. Loew in his description of this species says that the upper orbital cilia are black, but I can see only pale cilia in the specimens I have examined.

26 **Neurigona setosa** n. sp.

Figure 26.

Thorax dull green; abdomen yellow with black bands; hypopygium yellow; middle and hind coxæ with a prominent black bristle on the outside. Length 3-3¼ mm.

Male: Face narrow, of nearly equal width and silvery white; front and occiput greenish with white pollen; antennæ yellow, third joint and arista dark brown. Thorax dull greenish with yellowish pollen; the flattened space before the scutellum poorly defined, and with a depressed line in the center; pleuræ black with white pollen; humeri, metathoracic epimera, halters, and the root of the wing yellow; scutellum dull green with yellowish pollen, with the lower edge yellow, and a slightly elevated central ridge on the disk; metanotum black with white pollen; acrostichal bristles distinct, in two rows. Abdomen yellow; second segment with a very narrow, the third with a wider metallic greenish black band on the hind margin; fourth and fifth segments entirely metallic greenish black; venter yellow; hairs of the abdomen yellow; the black bristles on the hind margin of the first segment rather short; fourth and fifth segments ciliate with long yellow bristles on the lower lateral edges, these bristles more brown in certain lights; hypopygium yellow, brownish on the basal edge, with several yellow and two black appendages, the latter curved, mandible like, with a blunt triangular tooth on the inner edge near the center, and with long yellow hairs on the outside. Coxæ and legs yellow; hairs and bristles on the front side of the front and middle coxæ yellow; middle and hind coxæ each with a large black bristle on the outside; middle and hind femora each with a black bristle near the tip on the outside; middle femora ciliate with short yellow bristles on the lower surface towards the

base; tarsi scarcely infuscated at tips; front tarsi longer than their tibiæ; front metatarsi little more than one-half as long as their tibiæ; middle metatarsi two-thirds as long as their tibiæ; second joint of hind tarsi longer than first. Wings grayish hyaline, veins yellowish brown; posterior cross-vein less than twice its length from the wing margin measured on fifth vein; fourth vein gradually approaching third, ending before the apex of the wing, not far from the tip of third vein.

Female: Agrees with the male in most of the characters given, except in the following points; there are several black bristles near the tip of the front coxæ; abdomen with a row of black bristles on the hind margin of each segment; fourth and fifth segments of the abdomen, and the middle femora without cilia.

Described from four males and four females in the collection of the American Entomological Society, taken at Alamogordo, N. M., May 8-15, 1902. Type No. 5258.

Note.—I place this species in this genus for the present, but it differs from the other species of the genus by having the flattened space before the scutellum less distinctly defined; by the greater development of the appendages of the hypopygium; and by the bristles on the outside of the middle coxæ, and near the tip of the middle and hind femora; also the abdomen of the male is shorter and stouter than in most species of the genus.

27 **Neurigona tibialis** n. sp.

Figure 27.

Thorax yellow, with more or less greenish gray on the dorsum; abdomen yellow with black bands; hypopygium yellow, and very small; front tibiæ with a row of bristles above; wings with the third and fourth veins nearly parallel. Length 2½ mm.

Male: Face and palpi with white pollen, the former very wide for a male; antennæ yellow, first joint short and with three or four hairs above; third joint missing; front and occiput dark greenish gray, with white pollen; post-vertical bristles and some of the upper orbital cilia black, the lateral and lower orbital cilia whitish. Thorax yellow, with dark greenish gray on the center of the dorsum, which almost forms three broad vittæ, lateral ones abbreviated in front, and all somewhat united; pleuræ with a black spot above the middle coxæ, and another in front of the halters; scutellum and metanotum dark greenish gray, the former yellowish below; acrostichal bristles rather long but scattering, forming two poorly defined rows. Abdomen yellow, incisions black on the dorsum, this black extending forward so as to almost connect along the center of the dorsum on the second, third, and fourth segments; fifth segment all black on the dorsum and with a greenish luster; venter yellow; hypopygium dark yellow, very small, and with two pair of short, slightly hooked appendages. Legs pale yellow; front coxæ with pale yellow hairs and bristles, the larger bristles blackish in certain lights; middle coxæ with black hairs and bristles, one of the

latter rather long and placed high up almost on the outside; hind coxæ with one black bristle on the outside; front tibiæ with a row of black bristles above, these bristles do not reach either the base or apex; front tarsi about one and one-half times as long as their tibiæ, the metatarsi two-thirds as long as the tibiæ, second joint half as long as the first; middle tarsi a little longer than their tibiæ, the first joint one-half as long as the tibiæ; middle and hind femora with a black bristle near the tip on the outside; hind tarsi fully as long as their tibiæ, with the second joint longer than the first. Wings grayish hyaline; third and fourth veins only very slightly convergent at the tips.

Described from one male which I took at Lancaster, Erie Co., N. Y., on Aug. 15, 1909.

Note.—This species resembles *setosa* in having a bristle on the outside of each middle and hind coxæ, and near the tip of each middle and hind femora; also in having bristles on the hind margin of all the segments of the abdomen. The hypopygium is smaller than that of any other species of the genus that I have seen. There are three or four bristly hairs on the top of the first joint of the antennæ near the tip, but this joint is hardly hairy on top in the same way that it is in some of the genera of Dolichopodidæ.

28 **Neurigona ciliata** n. sp.

Figure 29.

Dorsum of the thorax black; abdomen yellow with black bands; hypopygium small, black; front tarsi black, fringed on each side with short black hairs; wings strongly tinged with brown in front of the third vein. *Length* 4½ *mm.*

Male: Face and palpi silvery white, the former very narrow, the eyes almost touching on the center of the face; proboscis and antennæ yellow, arista yellowish brown; front and occiput greenish gray, with white pollen; frontal bristles black, orbital cilia and post-vertical bristles whitish. Thorax black, shining on the dorsum, with white pollen, this pollen thickest on the flattened space before the scutellum; humeri, prothorax, lateral edges of the dorsum, scutellum except base, metathoracic-epimera, and a large triangular spot above the middle coxæ yellow. Abdomen yellow, with poorly defined, wide black bands on the dorsum at the base of segments two, three, and four, and a small spot at base of fifth; hairs black on the first four segments, pale on the fifth and on the venter; venter yellow; hypopygium small black shining, appendages testaceous. Legs pale yellow; front coxæ with pale hairs and bristles, one or two of these bristles black; middle coxæ with black hairs and bristles; front tarsi black, fringed on each side with short coarse, dense hairs, giving them the appearance of being flattened, these hairs hardly as long as the diameter of the tarsi; front metatarsi about equal to their tibiæ in length, fourth joint hardly twice as long as wide; middle metatarsi four-fifths as long as their tibiæ; middle legs

infuscated from the middle of the tibiæ, the tarsi becoming black; first and second joints of hind tarsi equal, black from the tip of the first joint. Halters, tegulæ and their cilia pale yellow. Wings brownish hyaline, much darker in front of the third vein; veins dark brown; third vein bent backwards at tip, fourth vein bent forwards from beyond the middle of the last section, the tips of third and fourth quite near together.

Described from one male taken at Doe Bay, Wash., July 16, 1909, in the collection of Prof. J. M. Aldrich.

29 **Neurigona perbrevis** n. sp.

Figure 30.

Dorsum of the thorax grayish green, with three brownish vittæ; abdomen black; hypopygium black, polished, and rather large; front tarsi with the last two joints flattened and fringed, forming an oval tip; front tibiæ longer than their tarsi. Length 3^{1}_{4} mm.

Male: Face rather narrow; face and palpi white; front and occiput seem to be black, but the ground color concealed by whitish pollen; orbital cilia white; antennæ yellow, the small third joint and the arista brownish. Dorsum of the thorax grayish green, thickly covered with pollen, (this pollen and that of the head and scutellum has a greenish tint). Dorsum with four brown vittæ, the lateral ones abbreviated in front; scutellum the same color as the dorsum, but the edges a little yellowish; pleuræ black with white pollen. Abdomen black, covered with white pollen which is thickest on the posterior margins of the segments; fifth segment with a yellow hind margin; venter yellow; hairs on the tergum black, those on the sides of the last three segments white; hypopygium shining black, polished, and rather large; appendages shining black. Legs yellow; front and middle coxæ with yellowish hairs and bristles; middle and hind coxæ darkened on the outside; front tibiæ longer than their tarsi or femora, which are of equal length; metatarsi longer than the remaining four joints together; fourth and fifth joints black, flattened, and fringed on each side, forming an oval tip, which is nearly twice as long as wide; middle metatarsi nearly three-fourths as long as their tibiæ; hind tarsi nearly as long as their tibiæ, the second joint a little longer than the first; hind femora with a few yellow bristles below near the base. Halters yellow; tegulæ and their long cilia whitish. Wings hyaline; fourth vein rather sharply bent towards the third, ending in the apex of the wing, not very close to the tip of the third vein; veins brown.

Described from two males in the collection of the American Entomological Society, which were taken at Alamogordo, N. M., on April 20 and May 12, 1902. Type No. 5257.

30 **Neurigona australis** n. sp.

Figure 31.

Dorsum of the thorax grayish green; abdomen with the dorsum entirely blackish; hypopygium shining black, large; front tarsi with the last two joints flattened and fringed with black hairs, forming an oval tip to the tarsi; front tibiæ shorter than their tarsi. Length of male and female 4½ mm.

Male: Face narrow, silvery white; palpi and proboscis yellow; front and occiput black, with grayish white pollen, the latter with purple reflections; orbital cilia white except a few of the uppermost which are black; antennæ yellow, third joint and arista brownish. Dorsum of the thorax grayish green, with some purple reflections, and grayish pollenose, with four brown vittæ, the lateral ones rather poorly defined; pleuræ and metanotum black, and covered with white pollen; a small yellowish spot below the humeri; scutellum the same color as the dorsum. Abdomen metallic black and covered with grayish pollen, which is thickest on the sides; fifth segment glabrous and shining; venter sordid yellow; hairs of the abdomen mostly pale, rather scattering, but longer and more abundant on the sides and posterior end; hypopygium shining black, large, polished, rounded behind, and with black appendages. Legs yellow; middle and hind coxæ blackened almost to the tip; front and middle coxæ with white hairs and bristles; front tibiæ and tarsi darker than their femora the tibiæ a little longer than their femora, and the tarsi nearly one and one-third times as long as the tibiæ, the last four joints flattened, fourth and fifth joints black and fringed on each side, forming an oval tip to the tarsi; front metatarsi nearly as long as the remaining four joints together; middle metatarsi about the same length as their tibiæ; a few weak yellow bristles on the lower side of the middle femora near the base; hind tarsi about the same length as their tibiæ, and the first joint longer than the second; last four joints of the middle and hind tarsi darkened. Halters, tegulæ, and their cilia yellowish. Wings hyaline, only slightly tinged with grayish; anal angle not prominent; fourth vein sharply bent towards the third, ending in the apex of the wing, not very near the tip of the third vein.

Female: Differs from the male as follows: the abdomen is lighter colored, more like the dorsum of the thorax; the front tarsi are plane; the middle femora without bristles below; and the first and second joints of the hind tarsi nearly equal.

Described from one male, and five females from New Mexico. The male and one female are in the collection of the American Entomological Society, and were taken at Cloudcroft, N. M., June 18, 1902; in the National Museum collection are three females, taken at Las Vegas, N. M., Aug. 7, 8, and 11, by S. H. Baker; and one female taken on the White Mountains, N. M., Aug. 5th, by Townsend, at 6500 feet altitude. Type in the collection of the American Entomological Society; type No. 5256.

31 **Neurigona albospinosa** n. sp.

Figure 32.

Thorax blackish, with three metallic brown vittæ; abdomen greenish black, segments gray pollenose at base; hypopygium small, testaceous; hind coxæ with several rather weak whitish bristles. Length of male 4–4½ mm., female 3½–5 mm.

Male: Face not very narrow for a male, and with the sides nearly parallel; face and palpi white; proboscis and antennæ yellow, the latter with the third joint and the arista dark brown; front and occiput dark grayish green with white pollen; orbital cilia white. Thorax and scutellum blackish, more gray on the dorsum, and with three somewhat shining metallic brown vittæ, the central one between the acrostichal bristles most sharply defined; thorax including scutellum and metanotum whitish pollenose, the pollen more brown on the flattened space before the scutellum, this brown pollen extends somewhat onto the scutellum. Abdomen metallic greenish black with coppery reflections, and a grayish pollenose band at the base of each segment; the hairs on these bands white, on the posterior part of the segments the hairs are black; the first segment wholly gray pollenose, and with the marginal row of bristles pale except about four at the top which are black; second segment with two transverse rows of black dashes near the base; venter of the first segment, and very narrow lateral edges of one or more of the others yellow; hypopygium testaceous, polished, and rather small. Legs pale yellow; front coxæ whitish with long white hairs on the whole front; middle coxæ also with white hairs and bristles; hind coxæ with one long and several weak whitish bristles on the outside; middle and hind coxæ blackish at base; front and middle metatarsi about two-thirds as long as their tibiæ; hind tarsi with the first joint shorter than the second; middle and hind tarsi infuscated from the tip of the first joint; hind femora brownish above. Cilia of the tegulæ whitish; halters yellow with the knob whitish. Wings brownish hyaline, darker along the front; third and fourth veins wide apart at tip.

Females: Agrees with the male in most characters, but the scutellum yellow, sometimes a little darkened at base; marginal row of bristles on the first segment of abdomen black, sometimes one or two of the lower ones yellowish; stout bristles on hind coxæ brown in some lights. Face broad, darker than in the male, and the palpi yellowish.

Described from seven males and twelve females, from Idaho, Wash., and Cal. I received from Prof. Aldrich specimens taken at Lewiston, and Juliaetta, Idaho, the latter taken May 7th; also specimens taken at Stanford University, Cal., Feb. 22 to March 24th. From Prof. Melander I received specimens from Wenatchee, Wash., taken May 8th.

32 **Neurigona minuta** n. sp.

Dark metallic green; arista white; hind coxæ with a yellow bristle on the outside. Length 2 mm.

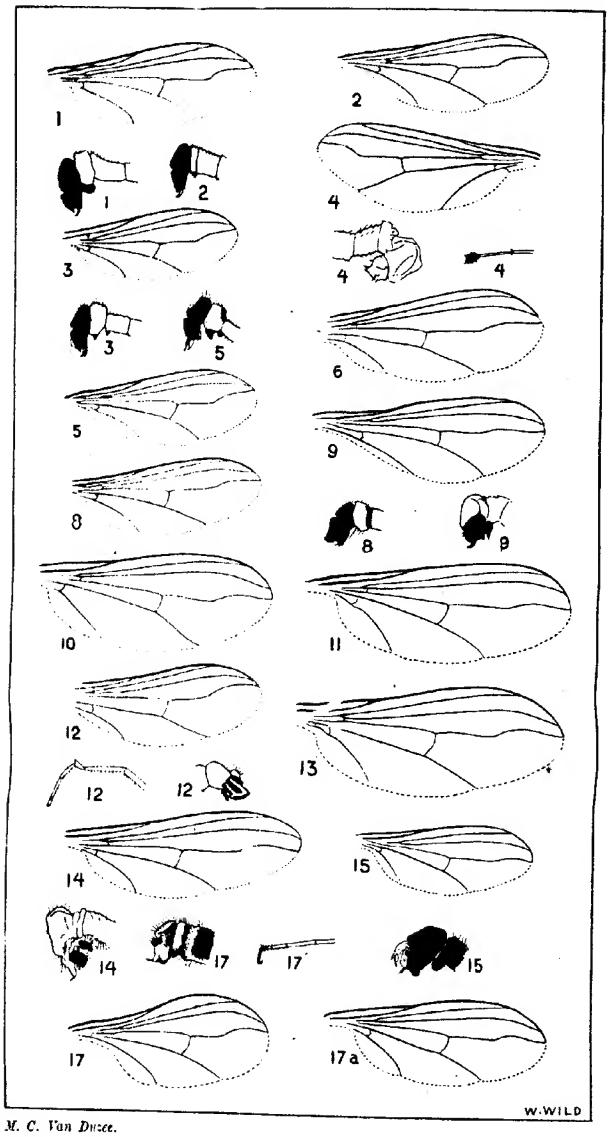
Female: Face, front and occiput greenish black, with but little pollen (at least in the type specimen); palpi and proboscis yellow, the former with minute black hairs on the surface and a black bristle at tip; antennæ dark reddish brown, the third joint rounded, hardly pointed, and more brown than the basal joints, the arista inserted near the apex, white. Thorax rather dark metallic green, covered with gray pollen; humeri with only a trace of yellowish; the flattened space before the scutellum not very sharply defined; bristles of the thorax strong, acrostichal bristles well developed, in two rows; the outer pair of scutellar bristles minute but distinct. Abdomen dark metallic green, with black hairs; venter dark. Legs and coxæ pale yellow; front coxæ with whitish hairs and bristles; middle coxæ with brownish hairs; the large bristle on the outer surface of the hind coxæ yellow; the hairs on all the legs very minute; front and middle tarsi about one and one-half times as long as their tibiæ, their first joint being about half as long as the tibiæ; middle tibiæ with two black bristles near the base, one on the front side, and one on the outer side; hind tibiæ with a row of four or five black bristles on the posterior surface; hind tarsi a little longer than their tibiæ, and with the first joint only half as long as the second. Halters, tegulæ and their cilia pale yellow. Wings hyaline, only slightly tinged with grayish; venation about as in N. aldrichii (Fig. 12), except that the posterior cross-vein is only its own length from the wing margin measured on the fifth vein, and the apical half of the last section of the fourth vein is nearly straight; veins brown, becoming pale yellow at the root of the wing.

Described from one female from Philadelphia, Pa., which was bred from decaying oak, May 23, 1907. Type in the collection of Prof. J. M. Aldrich.

Note.—This is the smallest species of the genus that I have seen, and is very distinct from all the others. It can readily be distinguished by the pale bristles of the coxæ, and its white arista.

EXPLANATION OF PLATES.

Fig. 1. Neurigona rubella Loew, wing and hypopygium of male.
" 2. " perplexa n. sp. wing and hypopygium of male.
" 3. " dimidiata Loew, wing and hypopygium of male.
" 4. " carbonifer Loew, wing, hypopygium, and tip of front tarsi of male.
" 5. " nitida n. sp. wing and hypopygium of male.
" 6. " tridens n. sp. wing of female.
" 8. " maculata n. sp. wing and hypopygium of male.
" 9. " floridula Wheeler, wing and hypopygium of male.
" 10. " floridula var. infuscata n. var. wing of female.
" 11. " flava n. sp. wing of female.
" 12. " aldrichii n. sp. wing, hypopygium, and front tarsi of male.
" 13. " transversa n. sp. wing of female.
" 14. " disjuncta n. sp. wing and hypopygium of male.
" 15. " viridis n. sp. wing and hypopygium of male.
" 17. " arcuata n. sp. wing, hypopygium, and tip of front tarsi of male.
" 17a. " arcuata n. sp. wing of female.
" 18. " deformis n. sp. wing, hypopygium, and tip of front tarsi of male.
" 18a. " deformis n. sp. wing of female.
" 19. " tenuis Loew, wing, hypopygium, and tip of front tarsi of male.
" 20. " pectoralis n. sp. wing, hypopygium, and tip of front tarsi of male.
" 21. " æstiva n. sp. wing and hypopygium of male.
" 22. " bivittata n. sp. wing of female.
" 23. " tarsalis n. sp. wing and hypopygium of male.
" 25. " lateralis Say, wing and hypopygium of male.
" 26. " setosa n. sp. wing and hypopygium of male, the latter is stretched out backwards.
" 27. " tibialis n. sp. wing and hypopygium of male.
" 28. " quadrifasciata Fab. (European) apical part of wing.
" 29. " ciliata n. sp. wing and hypopygium of male.
" 30. " perbrevis n. sp. wing, hypopygium, and tip of front tarsi of male.
" 31. " australis n. sp. wing, hypopygium, and tip of front tarsi of male.
" 32. " albospinosa n. sp. wing, and hypopygium of male.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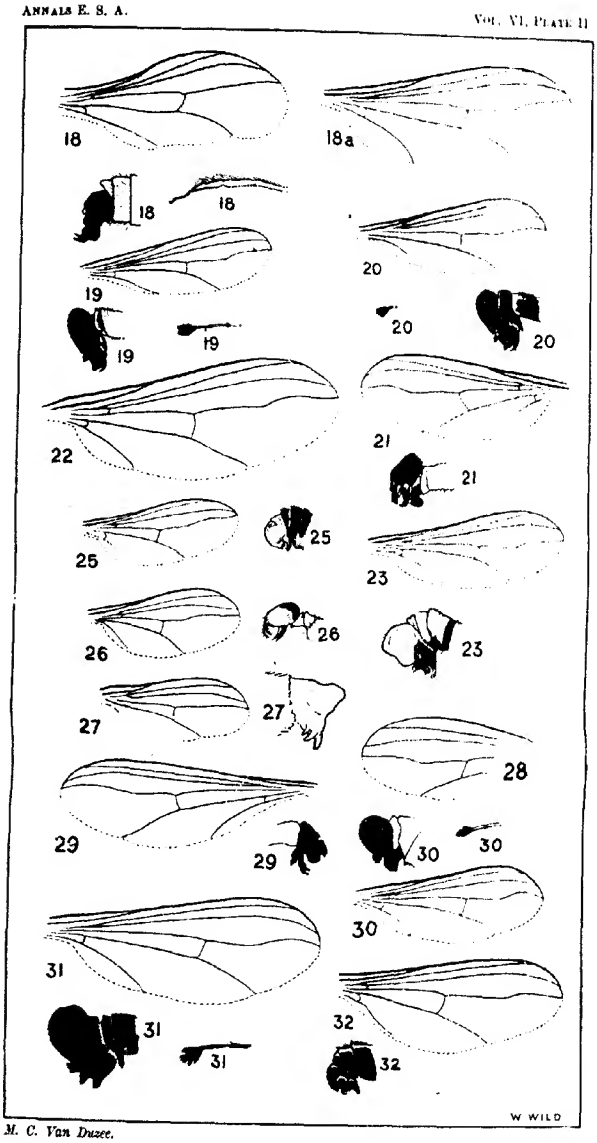
M. C. Van Duzee.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AN INTERESTING FEATURE IN THE VENATION OF HELICOPSYCHE, THE MOLANNIDAE, AND THE LEPTOCERIDAE.

By CORNELIUS BETTEN, Lake Forest College.

The conclusions recorded in a recent paper by Prof. Martynov* regarding the venation of the Trichopterous genus Helicopsyche lead me to anticipate here one of several somewhat revolutionary views on the venation of the Trichoptera to which I have come during the progress of work on a rather extended report on that order of insects.

For the sake of comparison a figure is here given of the venation of the fore wing of Rhyacophila (Fig. 1), representing an extremely primitive type. The homologies indicated in this figure are so simple as to require no comment except as regards the branches of subcosta (Sc) and of cubitus and the anals. None of these is here considered and attention is directed only to radius which in this genus appears in absolutely primitive condition, that is, with R_1 running free to the margin and with the radial sector (Rs) dichotomously branched. In very many Trichoptera there is a cross vein from R_3 to R_4 setting off what is called the discal cell. Near the base of cell R_4 (the cell bounded by R_4 and R_5) there is indicated a very small corneous point which is present in the vast majority of Trichopterous wings.

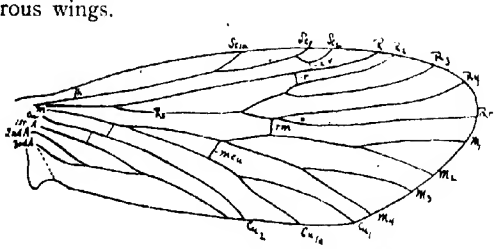

Fig. 1. Venation of fore wing of Rhyacophila sp.

Martynov reaches the conclusion that radius is also found in practically the typical condition in Helicopsyche (Fig. 2), that is, that cell R_4 in both fore and hind wings is not obliterated by the fusion of R_4 and R_5 as might at first sight appear to be the case.

*Martynov, A. B. On two Collections of Trichoptera from Peru. Annuaire du Musee Zool. de l'Acad. Imperiale des Sci. de St. Petersburg. Vol. 17 (1912), 40 pp., Figs. 1-59.

That this view is correct seems to admit of no doubt. In the American species (*H. borealis* Hag.) the relations are entirely clear. R_5 leaves R_4 at nearly a right angle and then again turns sharply to the wing margin; the cross vein rm meets the vein at the latter angle, and is in a nearly horizontal position. One might therefore easily be deceived into thinking that the cross vein rm and the distal part of R_5 with which it is in direct line together constitute a branch of media. A failure to recognize the true relation has forced most authors to leave this vein unidentified in their figures. The exact position of the base of R_5 varies somewhat within the genus and also within the species;

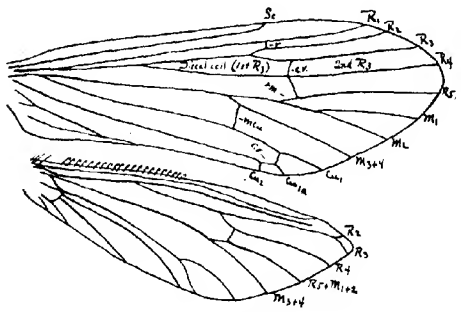

Fig. 2. Venation of Helicopsyche borealis.

in specimens of *H. borealis* (Fig. 2 and Fig. 3a) the cross vein rm is left intact though out of the usual position as already shown, in Martynov's figure (l. c., Fig. 2, copied in Fig. 3b) of *H. minuscula* the angle in R_5 just touches M_{1+2} so that the cross vein rm is obliterated and its function is assumed by the base of R_5, in Ulmer's figure of *H. borealis* (Genera Insect. Fasc. 60, pl. 11, fig. 98, copied in Fig. 3c) the base of R_5 has migrated still farther back so as to be still more deceptive in its resemblance to the cross vein which it has displaced. Ulmer has recently described some related fossil genera in one of which (Palaeohelicopsyche*) the female has the cross vein rm present while it has been displaced in the male.

*Ulmer, Georg. Die Trichopteren des baltischen Bernsteins. Schriften der physikalisch-ökonomischen Ges. zu Königsberg. Beiträge zur Naturkunde Preussens. Heft 10 (1912), p. 308.

Attention has already been called to the small corneous point that occurs in the base of cell R_4 in almost all Trichoptera. Perhaps the position of this point may be given some weight in the determination of the veins between which it occurs, as is done in the discussion of the venation of the Molannidæ and the Leptoceridæ given later in this paper. In the case of Helicopsyche the evidence from this source now available is incomplete and apparently contradictory. In Ulmer's figure of the closely related genus Tetanonema (Genera Insect. Fasc. 60, pl. 12, fig. 100) the corneous point appears in its normal position in cell R_4 but in his figure of *H. sperata* (l. c., pl. 11, fig. 97) and in the figures of several related genera

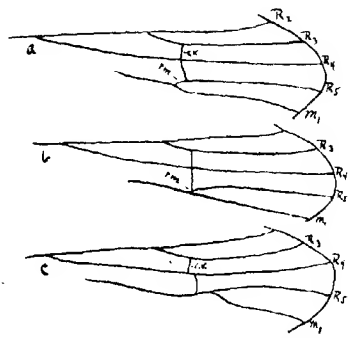

Fig. 3. *a*, Radius of the fore wing of Helicopsyche borealis. *b*, The same from H. minuscula (after Martynov). *c*, Another specimen of H. borealis (after Ulmer).

described in his fine work on the fossil forms it is found in cell 2nd R_3, that is, in the cell immediately anterior to the one in which it normally occurs. On the other hand this spot is not shown in McLachlan's figures of *H. sperata* and *H. borealis*, Martynov does not find it in *H. sperata* and the study of a large series of *H. borealis* fails to reveal a single occurrence. Since Ulmer's observations are on material in amber there may be greater chance for error though it seems unlikely that this should happen in several cases. At any rate, Tetanonema and Saetotricha, the only closely related modern forms, should be re-examined in this connection. If Ulmer's figures are correct these cases form the only exception to the rule that the corneous

point occurs, if it occurs at all, in the base of cell R_4. In some groups there is a similar spot in the distal part of cell M of the fore wing (Fig. 8). This spot which has apparently been but little noted, while it is characteristic of fewer groups of Trichoptera is as constant in position as are those of cell R_4 in the fore and hind wings.

On account of the reduced number of segments in the male palpus Helicopsyche has always been placed in the very heterogeneous family Sericostomatidæ though its isolated position within that family has been fully recognized. Its venation, as interpreted by Martynov, has some resemblance in the points here considered to the very abnormal venation of the Molannidæ and to that of the Leptoceridæ.

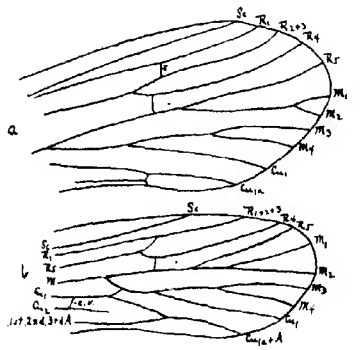

Fig. 4. *a*, Apical part of fore wing of Molannodes zelleri.
b, Same of Molanna cinerea ♀.

In the Molannidæ there has come about a very considerable shifting in the position of the veins as a result doubtless of the unusual position of the wings—these being rolled more or less about the body. In the European genus Molannodes (Fig. 4a) the condition with respect to radius is strikingly like that which is at least sometimes found in Helicopsyche (Fig. 3c), that is, R_5 has arched back into M_{1+2} obliterating the cross vein rm and leaving its own base in the regular position of that cross vein. There is a further reduction in the fusion of R_2 and R_3. In Molanna cinerea (Fig. 4b) there is a similar condition but R_{2+3} has also fused with R_1. In both genera M_{3+4} has migrated

upon Cu_1 just as R_5 has upon M_{1+2}. Radius of the hind wing may be similarly interpreted. While the limits of this paper preclude discussion of the other modifications, enough has been indicated to show that the determination of the homologies in the venation of the Molannidæ and the Beraeinæ need not be given up in despair.

While in the case of the Molannidæ the suggestions here made may help to bring order out of what has admittedly been chaos, it may seem that in extending the same interpretation to the Leptoceridæ the reverse is true. In this latter family there has been uncertainty as to the homology of the veins but the entire family is practically homogeneous in this respect and everyone seems to have been satisfied to recognize equivalents within these limits without determining the larger relations. Thus McLachlan (Rev. and Syn. p. 282) states that the application of the notation in this family (his section 3) is "not very satisfactory" and he leaves the veins and cells between R_3 and Cu_1 unidentified except in the genus Triaenodes and in the females of Leptocerus. In these latter cases there is apparently an evident recurrence of the 2nd and 3rd cells (cells R_4 and M_1) respectively, but as will be indicated further on this appearance may be illusory. Later authors have followed McLachlan's practice and no suggestion has so far been made as to the manner by which the evident reduction of the venation of the Leptoceridæ has come about.

The venation of a species of Leptocerus (Fig. 5) may serve as typical for the family. Attention is directed to radius of the fore wing which is similar in appearance in practically all members of the family and which apparently differs from the typical 5-branched radius only in having R_4 and R_5 fused. The only reason for questioning this interpretation is found in the fact that the corneous point then falls behind instead of in front of R_5. Exactly comparable conditions are found in the hind wing (Fig. 5b). It may possibly not be justifiable to discard the obvious interpretation of these veins because of the location of a minute structure whose significance is wholly unknown and whose position may therefore depend upon factors which have nothing whatever to do with the venation. It is, however, a most remarkable fact that while these points are absent in a few groups, they are never found outside of their respective cells no matter what curious modifications

these cells undergo. In fact a condition like that shown in Fig. 6 (Smicridea sp.) suggests that the corneous point submits to annihilation in preference to displacement.

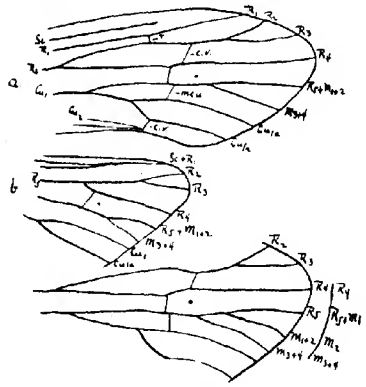

Fig. 5. *a*, Apical venation of fore wing of Leptocerus sp. ♂. *b*, Hind wing of same. *c*, Fore wing of female of same.

If then we give any weight to the comparison with Helicopsyche and the Molannidæ and to the position of the corneous points we should conclude that in the Leptoceridæ also R_5 has arched into M_{1+2} its distal end fusing with the latter compound vein and that what appears to be the cross vein rm is in reality the base of R_5.

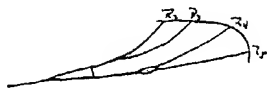

Fig. 6. Radial sector in the fore wing of Smicridea divisa.

In almost all of the Leptoceridæ media is reduced to two branches but in the subfamily Triplectidinæ and in females of the genus Leptocerus a more generalized condition obtains, that is, media is apparently three branched (Fig. 5c). If the view here advocated is correct these generalized Leptoceridæ are in exactly the same condition as regards the relation of R_5 and media as is Helicopsyche, that is, R_5 has arched into M_{1+2} but has not fused with it distally. There is of course the other possibility that it is M_1 and M_2 that are separate and R_5 and M_1

that have fused. The alternative interpretations are indicated in Fig. 5c. To decide between these possibilities we should have to find out which fusion took place earlier in the phylogenetic series and on this question the evidence seems inconclusive.

While the purpose of this paper is fulfilled in showing that the modifications of radius may be similarly interpreted in Helicopsyche, the Molannidæ, and the Leptoceridæ, another instance of similar modifications may be added lest the basal shifting of a distal branch from one main stem to another should seem unlikely in this order. A parallel case is shown in media of the fore wing of Oecetis*. Authors from McLachlan

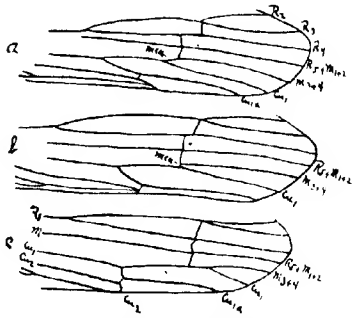

Fig. 7. Venation of apical part of fore wing of species of Oecetia. *a*, Oecetia fumosa. *b*, Oecetia incerta. *c*, Oecetia testacea (after McLachlan).

on agree in saying that media in Oecetis is absolutely simple or unbranched. No one seems to have been disturbed by the fact that on such an interpretation an extra branch would have to be assigned to cubitus. As a matter of fact media is always two branched in Oecetis as it is in most of the other Leptoceridæ. In *O. fumosa* (Fig. 7a) while there is slight variation in exact position, M_{3+4} leaves M_{1+2} at about right angles; it bends sharply and then proceeds to the wing margin. At the latter angle it is joined by the cross vein m-cu which is in line with the distal end of M_{3+4} so that the resulting deceptive appearance is that of an extra branch on the anterior side of cubitus joined to media by a cross vein which is in reality the base of M_{3+4}. In *O. incerta* (Fig. 7b) the cross vein m-cu is very short, in some

*I include here Oecetina Banks and Oecetodes Ulmer.

specimens it is wholly lacking. Finally in such forms as the European *O. testacea* (Fig. 7c) the base of M_{3+4} has migrated farther back on Cu_1 and in this position its true nature as a part of M_{3+4} is far from obvious. In such a case the vein becomes virtually a cross vein and migrates according to the mechanical stress in flight without reference to the distal part of the vein which is left stranded with a new basal connection. Other instances of this sort occur in the Trichoptera and they are not uncommon in other orders.

The facts here presented may be of some significance in their bearing on the question of the systematic position of the Helicopsychinæ. This subfamily has always been placed in the Sericostomatidæ because of the unequal number of segments in the palpi of the male and female, though it has always been clearly recognized that it bears no close relationship to any of the heterogeneous groups included in that family. Thienemann, Ulmer, and Martynov have each suggested that a new subfamily should be erected for the genera Helicopsyche, Tetanonema, and Saetotricha, and Ulmer and Martynov have during the past year almost simultaneously described the subfamily Helicopsychinæ, Ulmer's description being slightly the earlier.

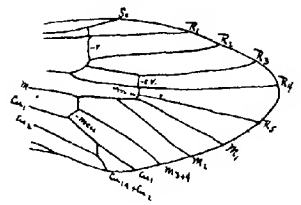

Fig. 8. Venation of apical part of fore wing of Sericostoma sp.

In his recent work on the fossil forms Ulmer lists the Helicopsychinæ among the Sericostomatidæ but in this work (p.376) he makes the first suggestion that these forms may possibly show affinities to the Leptoceridæ though he gives, so far as I can find, no reason for the statement. What has been given above certainly confirms the impression which Ulmer has stated since in the Helicopsychinæ, the Molannidæ, and the Leptoceridæ, R_5 shows an increasing tendency to migrate upon M_{1+2}—a condition not seen elsewhere in the Trichoptera, though the sharp angle in R_5 seen in Sericostoma (Fig. 8) and other forms might be regarded as a beginning of that tendency.

It is interesting to note that there are some other characters not found in the Sericostomatidæ which Helicopsyche shares with genera of other familes. Thus it has the costal hooks on the hind wings which are found well developed only in the Leptoceridæ, Molannidæ, and the Macronematinæ (Hydropsychidæ). I find also that *H. borealis* has the peculiar fenestrated terga in the posterior abdominal segments heretofore found only in certain species of Oecetis—a genus of Leptoceridæ.

Taken altogether the facts presented do not do more than emphasize the isolated position of the Helicopsychinæ and suggest that this subfamily may be regarded as an early offshoot from the Leptocerid stem which in the condition of the palpi has diverged from the typical form in the same way as have the Sericostomatidæ.

HOMOLOGIES OF THE WING VEINS OF THE MEMBRACIDAE.[1]

W. D. FUNKHOUSER.

INTRODUCTION.

Since in problems of phylogeny and taxonomy of insects the homologies of the wing-veins are being taken more and more into consideration, it is evident that the available data on this subject should be as complete as possible.

In the work which has been done along this line, certain families of the Homoptera have received but little attention and of these the Membracidæ appear to have been entirely neglected. For this reason, and because of a large personal interest in this group of bizarre insects, this study has been undertaken, hoping that it might be possible to add in some measure to the knowledge of hemipterous wings.

The work was begun two years ago at the suggestion and under the direction of Dr. MacGillivray, then of Cornell University, and has been completed under the supervision of Dr. Bradley, of the Entomological Department of Cornell, to both of whom I am greatly indebted for their most helpful criticisms and suggestions and for access to the specimens in the Cornell collection for examination and comparison.

METHOD.

Of the various methods of approaching the subject of wing-vein homologies, the Comstock-Needham theory[2] that the study should be based on the ontogenetic consideration of the tracheæ which precede the veins has been so fully established and is so applicable to the membracid wing that any other method of procedure in the examination of this highly specialized and complex homopterous type would appear to be the merest guess-work. It has been a source of the greatest satisfaction in the application of this theory to find that the nymphal tracheation has proven in most cases an open index to the adult venation, while the variation and peculiarities of many veins can be traced directly to the behavior of the tracheæ which preceded them.

1. Contribution from the Entomological Laboratory of Cornell University.
2. The Wings of Insects, Am. Nat. XXXII and XXXIII, 1898, 1899.

According to this theory the knowledge of homologies is dependent upon two methods of investigation. First, the ontogeny of the wing of the individual, as based on the study of the tracheation of nymphal wings traced through their successive stages of development, and second, the study of the wings of adults worked out by careful comparison with forms representing known types of venation. Of these two methods, the former has been the one used almost entirely and the second has been resorted to only for those forms for which the nymphs were not available. Since, however, the venation of the Membracidæ is comparatively uniform, the determination of homologies, after the tracheation of the nymphs of the more prominent types has been ascertained, has proven a relatively simple matter.

TECHNIQUE.

The laboratory methods followed have been in the main those outlined in the "Wings of Insects"[3] with such modifications as have been suggested by the condition and shape of the individual wings under consideration.

The wings were dissected from nymphs of various stages of development, but it was found that in most cases the last two instars showed best the features desired. In these two instars the nymphal wings may be pulled out of the wing-pads and are thus more easily studied. In the earlier stages, and in all of the stages of some of the smaller species, e. g. *Vanduzea arquata* or *Micrutalis calva*, it is difficult to remove the wing from the pad without disturbing the position of the tracheæ, and in these cases it is necessary to photograph through the pad membrane. The wings were carefully dissected out, together with a portion of the thorax to show the basal tracheation, and mounted at once. It was found that fresh material gave much better results than that which had been preserved, even for a short time, in formol or alcohol. In many cases, several hundred dissections were made for the verification of some particular point in question. The greatest difficulty was to preserve the tracheæ for a sufficient length of time to secure photomicrographs or careful drawings, since the tracheæ fill in a very short time with the mounting media and are then invisible. Moreover,

3. American Naturalist, Vol. XXXII, p. 45.

in the membracid wing, there is a sharp bend at the point at which the tracheæ enter the body and it is difficult to secure a mount in which the base and tip of the wing are in focus at the same time.

Various mounting media were tried, but for the wings of this family glycerin jelly was uniformly the most satisfactory. A drop of jelly was placed on the slide, the wing laid in the jelly, another drop placed on the cover-slip and the latter placed at once over the specimen. The mount was then quickly cooled by placing a drop of ether on the cover-slip and fanning it to insure rapid evaporation. Some of the mounts made in this way have remained in good condition for over a year and bid fair to last for a much longer period.

Photomicrographs were then made of the specimen, using whatever combination of objective and bellows were necessary to bring out the desired details and to make the image fill a 5x7 plate. Since many of the nymphal wings are less than two millimeters in length, the magnification is necessarily great, but negatives can usually be secured sufficiently sharp to show the points in question. Artificial light, secured by means of a Nernst lamp and series of condensers, seemed to be more desirable than sunlight for this work, mainly owing to the fact that it was possible to secure a chart of uniform exposures for the different magnifications.

In cases where photomicrographs were not considered necessary, careful camera lucida drawings were made, verified by repeated comparisons. For the adult wings, the permanent mounts (Canada balsam) of the wings themselves were used, copied by projection drawings when figures were desired.

Velox and solio prints from all negatives were made for permanent records in this study. The figures of nymphal wings shown in this paper, however, are blueprints inked in with india ink and afterwards bleached.[4] The figures of adult wings are pen drawings made from the permanent mounts with the aid of the camera lucida or projection apparatus.

4. In a saturated solution of Potassium Oxalate.

MATERIAL

Nymphs

About twenty species of the Membracidæ, representing eight genera of fairly wide distribution as regards relationship are common to the local fauna of Ithaca, New York, the nymphs of most of which are easily obtainable. These have been used for the determination of the nymphal tracheation. The choice of the various species studied has depended largely upon the characters of the adult wings. In cases of closely related forms where the venation was practically identical and no special problems were involved, the nymphs of a representative species only have been thoroughly worked out, except for the solution of certain questionable points. Some nymphs, also, owing to the form of the wing yield much better preparations than others, and these have been more elaborately figured where general characteristics only were being considered. Some have been discarded because of lack of positive identification and others because of the fact that they were less abundant and illustrated no features not found in forms more easily procured. The bulk of the work has been done from nymphs of the following genera: *Ceresa* (*bubalus, diceros* and *constans*), *Thelia* (*bimaculata*), *Telemona* (*ampelopsidis*), *Vanduzea* (*arquata*), *Campylenchia* (*curvata*) and *Enchenopa* (*binotata*). Altogether several thousand dissections have been made and each point in tracheation has been as carefully verified as possible. No attempt has been made to breed the insects since extensive field notes on the habitat, hosts, life-history and general biology of the local forms has made it possible to procure the nymphs at various stages without particular difficulty.

Adults

Besides the forms represented in the local fauna, the wings of all other species procurable have been studied with the view of obtaining a large number of types of venation. The writer is greatly indebted to the Entomological Department of Cornell for the privilege of examining the wings of all the species in the excellent collection of the University, which includes many forms that could not otherwise have been obtained. Thanks also are due to Dr. J. C. Bradley and to Mr. C. R. Plunket for the use of specimens from their collections.

Six subfamilies are recognized in the Membracidæ by the systematists in Hemiptera[5] and representative genera from all sub-families reported from the United States[6] have been examined. Wings from the following genera are figured in this paper as representative:

SMILIDA
- *Cerasini*
  - Ceresa
  - Stictocephala
  - Acutalis
  - Micrutalis
- *Telamonini*
  - Carynota
  - Thelia
  - Glossonotus
  - Telemona
  - Telemonanthe
  - Archasia
  - Heliria
- *Smiliini*
  - Smilia
  - Cyrtolobus
    - Cyrtolobus
    - Atymna
    - Xantholobus
  - Ophiderma
- *Polyglyptini*
  - Vanduzea
  - Entylia
  - Publilia

DARNIDA
- Stictopelta

HOPLOPHORIDA
- Platycotes

MEMBRACIDA
- Campylenchia
- Enchenopa
- Tylopelta
- Philya

CENTRODITA
- Centruchoides
- Platycentrus

(The above classification is based on that of E. P. VanDuzee in his "Studies in North American Membracidae," Bulletin of Buffalo Society Natural Science. 1908. Vol. IX.)

5. Cf. Stal, Hemiptera Africana IV, pp. 82–83.
Goding, Bibliographical and Synonymical Catalogue of the Described Membracidae of North America. Bull. Ill. State Lab. Nat. Hist., Vol. III, Art. XIV, p. 302.
VanDuzee, Bull. Buffalo Soc. Nat. Sci. 1908, Vol. IX, p. 31.

6. According to VanDuzee (*Studies in North American Membracidae, p. 31*) the Tragopida are not represented in this country. Moreover in this sub-family the fore wing at least is coriaceous and opaque externally, and would probably be of little value in the study of venation.

In addition to the species actually examined, careful comparison has been made with as many figured wings of the Membracidæ as could be located[7] and it has been a satisfaction to note that in practically all cases there is a constant and easily worked out agreement with the homologies as herein suggested.

Since the Membracidæ is principally an American family, only a few genera being found on the continent of Europe[8], but two species in Britain[9] and very few reported from other parts of the world, there seems no reason to believe that our local forms in New York should not be typical of the family. Moreover, the venation is quite uniform throughout the family and it appears reasonable to suppose that the homologies as here worked out for the representative genera figured will be readily applicable to the entire Membracidæ.

NOMENCLATURE

Many of the specific, generic and sub-family distinctions in the Membracidæ are dependent upon the venation, and most tables and keys to the family follow the nomenclature of Fowler, Goding and others in which the characters of the cells are used as a basis of classification. Little attention has been paid to the veins except as to their number at the base of the wing or as forming the "petiole" of a cell.

The cells are called "areoles" or "areas" and are described as "marginal", "discoidal", "apical", "anterior", etc., and their bases as "petiolate", "truncate", etc., but little attempt has been made to identify the veins which limit these cells. Fowler in his discussion of the Ceresini in the Biologia[10] describes the "costal", "radial" and "ulnar" veins, and this nomenclature has been used to some extent by other writers.

The fore wing is commonly spoken of as the tegmina and its venation often designated as the elytral venation. The hind wing is referred to as the under wing or the second wing. The corium is often discussed separately, as is also the clavus

7. In the plates of Canon Fowler in the Biologia Centrali Americana particularly, the figures, while representing forms foreign to our fauna, are evidently very accurately reproduced and agree to a remarkable extent with our North American species, so far as venation is concerned.

8. Canon Fowler. Bio. Cent. Amer., Insecta: Rhynchota, Homoptera. Part II, p. 2.

9. Cambridge Natural History, Insects Part II, p. 577.

10. Biologia Centrali Americana, Insecta: Rhynchota, Homoptera. Part II, p. 87.

and the membranous margin, and altogether a rather complex and imposing accumulation of terms has been built up, not at all contradictory, but somewhat confusing.

It would be entirely unnecessary and out of place at this point to enter into the controversy regarding the systems of nomenclature of wing-veins and their respective merits, a subject which has been thoroughly and repeatedly reviewed[11]. The nomenclature used in this study is entirely that of the Comstock-Needham system, and therefore the veins and cells here described conform to those represented in other work done according to this system. The names "costa", "subcosta" "radius", "media", "cubitus" and "anal" will be used throughout. Thus the "terminal areole" of VanDuzee, the "third apical area" of Fowler and the "celule terminale" of Fairmaire becomes cell R^5 as dependent on the homology of the vein R^5, and will be so designated in this discussion, and this same system will hold for all other veins and cells discussed.

THE MEMBRACID WING

The Membracidæ is one of those families of the Homoptera in the wings of which the corium and clavus are usually membranous, the veins in most forms are distinct, there is practically no thickening at the base of the wing, and both pairs of wings are well developed (Fig. 1). These features are better shown in the membracid wings than in those of any of the other Hemiptera with the possible exception of the Cicadidæ. The wings are well adapted for flying and the insects fly well for short distances with a whirring noise.

The fore wings are large, expanded and distinctly veined. They are usually membranous throughout, but occasionally show coriaceous patches and basal punctures, especially along the anterior margin. The clavus[12] is distinct, the claval suture

11. The historical discussion of the nomenclature of wing-veins is taken up in detail by Dr. A. D. MacGillivray in the "Wings of Tenthredinoidea," Proc. U. S. Museum, 1906, Vol. XXIX, pp. 570–574.

Miss Edith M. Patch reviews the terminology of homopterous wing venation in "Homologies of the Wing-Veins of the Aphididae, Psyllidae, Aleurodidae and Coccidae," Annals Entomological Society of America, 1909, Vol. II, pp. 124–126.

Cf. also C. W. Woodworth, The Wings of Insects. University of California Publications, Agricultural Experiment Station Technical Bulletin, Entomology. Vol. I, p. 142.

12. In the hemipterous wing the basal portion consists of two pieces. The term "clavus" is here applied to the narrow posterior piece which is next to the scutellum when the wing is closed. This is figured in Comstock's "Manual for the Study of Insects," p. 124.

occurring along the first anal vein. There are few cross-veins but those present are remarkably constant. The wing may or may not be covered by the pronotum, but in no case is it to be considered in the sense of an elytron.

The hind wing is not nearly so dissimilar to the fore wing as is the case in most insects. C. W. Woodworth in the "Wings of Insects"[13] remarks that "the hind wings of most of the families of Homoptera have more nearly kept pace with the front wings in their specialization, than have those of the Heteroptera". This is certainly true of the Membracidæ. There are fewer veins and cells in the hind wing than in the fore but their homologies are evident.

Both wings are characterized by the strongly scalloped margin of the veined surface and the comparatively narrow terminal membrane.

Like most of the other Hemiptera, the wings of the Membracidæ are specialized by reduction, but the reduction has not been carried so far as in most of the other families of this order. This reduction has been carried on in two ways, viz.: by atrophy and by coalescence. Reduction by atrophy is shown by costa in both wings. Coalescence, in turn, has been accomplished by two methods—by coalescence from the base towards the margin, as illustrated by cubitus, and by the anastomosis of veins in the center of the wing followed by their subsequent divergence, as shown in the case of radius four-plus-five plus media one-plus-two. No cases have been noted of coalescence from the margin proximad.

However, no hint of the particular veins in which this specialization occurs is given by the venation of the adult wing, and it is only by following the nymphal structure, trachea by trachea, and branch by branch, that the actual solution can be reached with any degree of accuracy.

NYMPHAL TRACHEATION

A study of the most general characteristics of the nymphal tracheation may well be made before proceeding to the consideration of the minutia. In the fore wing (Fig. 2), it will be noted that there are five main tracheæ. Beginning at the anterior margin, the first is unbranched and extends almost to the tip of the wing. The second appears two-branched and the posterior branch anastomoses for some distance with the ante-

13. Univ. of Cal. Publ., Ag. Ex. Sta. Tech. Bull. Ent., Vol. I, No. 1, p. 124.

rior branch of the following trachea. There is also a suggestion of splitting near the base of the anterior branch. The third is two-branched with the anastomosis as noted. The fourth is two-branched, the tracheæ separating very close to the base of the wing. The last is also two-branched with the branches coalescing at their extremities.

The relationship of these treacheæ with the corresponding wing veins is evident. Their identification as regards the homologies of wing veins in general is not so simple a matter. For this reason the veins as dependent on these tracheæ will be discussed in order, beginning at the costal margin.

FORE WING

Costa

Costa never appears as a separate vein in the adult wing. It was some time in the course of this study before sufficient data was obtained to determine exactly what had become of this vein, since most of the preparations failed to show a corresponding trachea in the nymphal wing. Finally however, an examination of younger stages of various species furnished the solution. In Thelia bimaculata (Fig. 3) it was found that costa was represented in the nymphal tracheation but never entered the wing for a sufficient distance to have a place in the adult structure. In most individuals the atrophy was greater than that shown in the figure. In *Telemona ampelopsidis* (Fig. 4) the treachea is twisted around the subcosta and no doubt coalesces with it in the vein which afterwards encloses them. In *Ceresa borealis* (Fig. 5) the trachea extends farther into the wing but is not so well developed and probably has no effect on the venation. In *Vanduzea arquata* (Fig. 6) much the same appearance is shown except that the trachea is stronger and lies nearer the margin of the wing.

To sum up then, the trachea which usually precedes the costal vein *is* represented in the nymphal structure but the vein itself is not found in the adult wing. In such genera as *Thelia*, *Acutalis* and *Glossonotus*[14] in which a slight membrane is found cephalad of subcosta but no thickened ridge is present, the vein is probably atrophied[15].

14. All forms mentioned are figured either through the text or at the end of the discussion. The figures of adult wings are drawn to show the coalescence of tracheae to form a single vein when such has been the case.

15. This is no unusual condition with costa. Comstock and Needham say (Wings of Insects, p. 858). "Its (costa's) trachea is often atrophied, probably owing to the disadvantageous position of its base in relation to air supply, as we have hitherto indicated."

In *Ceresa*, *Micrutalis*, *Telemona*, etc., in which subcosta forms the cephalic margin, the tracheæ for costa and subcosta have coalesced. In *Heliria*, *Vanduzea* and *Enchenopa* the trachea has had an influence on the costal margin to form a thickening near the base of the wing.

Subcosta

Subcosta is constant in character throughout the family. It is strong, straight and unbranched and extends the full length of the wing (Fig. 2). It is the anterior vein of the wing, owing to the atrophy of costa, and as such often forms the cephalic margin. In the sub-families Hoplophorida and Membracida[16] the vein is usually contiguous to the anterior margin for its basal half, and then drops down, leaving a terminal membrane anterior to its distal half. Sometimes this membrane occurs down the entire cephalic margin. No splitting occurs at the end of the vein. It sometimes anastomoses with parts of radius as will be shown in the discussion of that vein, but this is due to the peculiarities of radius and to no irregularities on the part of subcosta. Its base occasionally shows a fullness or slack which later straightens out in the vein formation (Fig. 7). Altogether, subcosta is always permanent, straight, clean-cut and independent, both in its tracheation and in its final structure.

Radius

The behavior of radius offered one of the most difficult problems of the membracid wing. Instead of the typical five-branched condition (Fig. 8) we have in the venation of this family (Fig. 2) what is seemingly a two-branched condition, with what appears to be a cross-vein connecting the cephalic branch with subcosta. This, in itself, would offer but little difficulty, since if the reduction of the five-branched type were carried far enough by coalescence outward, it would give a two-branched result. The natural method of reduction of radius is by the coalescence of the branches of each half of the radial sector, leaving the sector two-branched and the vein as a whole three-branched. If the same method of reduction be carried further, R_1 and the sector only are left, giving a two-branched condition of the whole vein.

16. See figures of Platycotes, Phylia, Campylenchia and Enchenopa. Nos. 51, 52 and 53.

But in the Membracidæ several points not compatable with this natural method of reduction presented difficulties. In the first place, both branches showed constant and unmistakable signs of further subdivision at their tips, which would not be likely to be true of the cephalic branch if it were R_1. Moreover, the vein between the cephalic branch and subcosta was often seen to be preceded by a trachea. Again and again in mounts of different species this area contained a trachea which was evidently a branch from the cephalic branch of radius. If this were true, this most anterior branch should be R_1. But R_1 normally leaves the main stem proximad of the division of the radial sector, while this branch seemingly pulls off from one half of the sector itself, and this demanded an explanation which was not immediately forthcoming.

The solution was first found in the wings of *Vanduzea arquata* and later this peculiar condition (Fig. 9) was verified in other genera. The trachea representing R_1, as will be seen from the figure, is weak and apparently greatly reduced. It leaves the main stem in the normal postion, but runs in close juxtaposition to the radial sector beyond the point at which the latter branches. Here it turns cephalad and runs across to subcosta where it again turns outward and closely parallels subcosta for some distance in its course toward the tip of the wing. The sharp turns made by the trachea in following this course (Fig. 10) are remarkable, and in the veins which enclose this region of the wing, the bridge from radial sector to subcosta (Fig. 11) gives every appearance of a cross-vein.

While this interesting behavior of R_1 is unusual, and perhaps peculiar to the Membracidæ, it only illustrates another of the vagaries of which radius is capable. In fact, throughout the Hemiptera, radius seems to be most unreliable, and R_1 capable of the most peculiar performances, being, according to Miss Patch[17] "the least stable of the hemipterous wing veins". It has been shown in the Cicadidæ[18] that R_1 has been crowded by subcosta until its trachea coalesces for its entire length with radial sector and its anterior branch. In the Pentatomidæ[19] also, it has been supplanted by subcosta and is entirely

17. Annals of the Entomological Society of America, 1909, Vol. 2, p. 119.
18. Wings of Insects, p. 245.
19. Wings of Insects, p. 250.

atrophied. In the Coreidæ[20] R_1 is wanting. The weakness of the vein has been remarked in the Aphididæ[21] and it is entirely lacking in the Psyllidæ[22] and in the Aleurodidæ[23]. In fact, Comstock and Needham state[24] that the complete absence of the vein R_1 is one of the most characteristic features in the venation of the wings of the Hemiptera.

It is of some phylogenetic interest, then, to note that in the Membracidæ, while the vein is abnormal, it is *not* completely absent, and in this respect the membracid wings may be considered the most generalized of any of the families of Homoptera, at least those of which the homologies of wing-veins have been determined.

Most of the genera of the Membracidæ show the position of R_1 as described. In many it has been impossible to find the trachea, although the vein is present and constant. Since, however, the history of the vein is evidently traceable to the trachea representing R_1, it seems necessary to call this vein R_1 whenever it appears.

In a few genera, namely, *Acutalis*, *Tylopelta*, *Enchenopa*, *Campylenchia*, *Platycentrus*, and *Centruchoides*, the vein comes off in its normal position. In the nymphal wings of *Enchenopa binotata*, for example (Fig. 12), the trachea is found in its natural place. These genera are, of course, still more generalized with regard to this special point, but are not so typical of the family.

The course of the rest of radius is evident from the tracheation. At its base it often anastomoses for some distance with media before these two principal veins separate for their respective courses through the wing. In *Ceresa*, *Stictocephala*, etc., this coalescence must be fairly constant, since it has been made a basis for classification[25]. R_{2+3} usually extends undivided to the tip of the wing. It is generally connected with R_{4+5} by a cross-vein. R_{4+5} is represented as one vein and coalesces with the anterior branch of media (M_{1+2}) for a more or less extended part of its course. The amount of coalescence

20. Wings of Insects, p. 252.
21. Annals of the Entomological Society of America, 1909, Vol. II, p. 111.
22. Annals Ent. Soc. of Amer., 1909, Vol. II, p. 119.
23. Annals Ent. Soc. of Amer., 1909, Vol. II, p. 122.
24. Wings of Insects, p. 245.
25. Biologia Centrali Americana, Insecta: Rhynchota, Homoptera, Part II, p. 87.

shown in figure 11 is about the average. In a few species[26] the course is more extended, and in some[27] the veins do not coalesce at all but run some distance apart, connected by one or more cross-veins. Just before reaching the tip of the wing, however, this vein separates from media to make the apical or terminal cell, which is thus cell R_5. The tips of both branches of radial sector show signs of splitting in their tracheal condition. In some cases they actually remain separate and form additional cells in the wing. This is true of the species *Telemonanthe pulchella*, *Cyrtolobus vau* and *Smilia camelus* (see figures Nos. 39, 43 and 42). In the first, R_2 and R_3 are separate. In the second, a very small cell R_4 appears, showing that R_4 and R_5 have not entirely coalesced.

In this species also, a peculiar condition of R_3 is shown, the end of the vein still persisting at the margin of the wing, while its base has disappeared. In *Smilia camelus*, R_3 has not entirely coalesced with R_2, and extends into the cell R_{2+3} where it is perhaps atrophying back toward its base. This means that in these forms the reduction has not proceeded so far as it has in the majority of the species.

Summing up, then, radius is typically three-branched in the Membracidæ. R_1 extends from R_{2+3} to subcosta. R_{2+3} and R_{4+5} usually extend as undivided branches, with the exceptions noted, to the tip of the wing, R_{4+5} ordinarily anastomosing for a variable part of its length with M_{1+2}.

Media

The course of media (Fig. 13) is quite constant. Starting from the base of the wing in close proximity if not in actual contact with radius, it follows a relatively straight course for about two-thirds of the wing length. It represents the most posterior vein of the costa-subcosta-radius-media group, and its origin is intimately connected with the stem of these veins (Fig. 14). In such forms as *Acutalis*, *Micrutalis*, *Thelia*, and *Carynota* of the Smiliida, this close connection is not shown in the adult wing. In others, as *Ceresa* and *Stictocephala*, the relationship is striking, as has been referred to in the consideration of radius.

26. e. g., *Cyrtolobus vau* and *Atyma castaneae*.
27. *Platycotis sagittata*, *Enchenopa binotata*, *Campylenchia curvata*, *Centrotoides perdita*, and *Platycentrus acuticornis*.

In the distal third of the wing, media branches into M_{1+2} nd M_{3+4}, the upper branch usually but not always uniting ith R_{4+5}. This is, in most cases, the end of its branching, nce the reduction by coalescence outward has obliterated the ıdividual veins M_1, M_2, M_3 and M_4. In a few cases these eins persist to the point of forming an extra marginal cell. his is true of *Archasia belfragei* and *Ophiderma pubescens*, here M_3 and M_4 are separate, and in *Micrutalis dorsalis* where I_1 and M_2 show a very slight space between them. In the ıtter species this feature, which has been remarked by VanDuee in a taxonomic sense[28], is not always constant. In *Smilia ımelus*, M_4 has behaved much as has R_2 in the same species see radius) by extending part way into cell M_{3+4} and probably trophying toward its base. A peculiar condition is shown in *Xanthologus trilineatus* in which M_1 and M_2 have not coalesced, ıus leaving a cell M_1. M_3 has coalesced with M_2 near the marin of the wing to form the unusual combination M_{2+3}. M_4 ctends part way into cell M_{3+4} as was seen in the case of milia.

On the whole, media represents a simple, natural reduction nd is one of the most constant veins in the membracid wing.

Cubitus

With the consideration of cubitus comes a perplexing roblem in interpretation. There is no doubt as to the tracheaon, which is constant throughout the family, but the homologies are not at once evident. From the posterior base of the ing, and separate from the costa-subcosta-radius-media group, ome two distinct main stems (Figs. 5 and 15). These must epresent cubitus and the anals. The upper stem is typically wo-branched which is characteristic of cubitus; the lower is ıree-branched and seems naturally to be First, Second and hird Anal respectively (Fig. 16). Certain features, however, ıake this interpretation unacceptable. The first and most nportant of these is the fact that the point of branching of the ıterior trachea occurs so far back in the nymphal wing that it ould not appear, and does not appear, in the adult venation. his is entirely inconsistant with the reduction which has taken ace in all of the other veins of the same wing, and it is inconivable that while coalescence outward has been taking place

28. Studies in North American Membracidae, p. 52.

in all the rest of the wing, cubitus has been dividing in the opposite direction. Moreover, the end of the cephalic branch shows, as did radius and media, unmistakable evidence of a doubly tracheated condition (Fig. 17). At first this was considered as a mere splitting of the end of the trachea and was disregarded. It appeared so constantly, however, and at times extended so far back into the wing, that it refused to be ignored. Again, it has been shown in other families of the Homoptera, that the first and second anal veins may be widely separated[29], the first anal arising from the cubital stem. In view of these facts then, it appears that the most anterior branch of the upper vein represents both Cu_1 and Cu_2. That these veins have coalesced outward in the regular manner, forming one vein only in the adult wing, although the two tracheæ are distinguishable in the nymphal condition. This interpretation makes the position of the anal fold in the membracid wing agree with the position which it assumes in the other Hemiptera, namely, along the first anal vein. If the next vein (First Anal) were considered as Cu_2 it would make the Membracidæ peculiar in this respect, and not in keeping with the conditions in the closely related families.

The trachea runs parallel with media for about half the length of the wing and then makes an abrupt turn downward, running to the posterior margin. At this point it divides, the two branches however never separating but turning together outward again toward the tip. The vein which encloses them follows this course without deviation. Just after the vein makes the sharp turn caudad, a strong cross-vein connects it with M_{3+4}. This cross-vein (medio-cubital), as will be shown later, may be of varying length but is constant and very characteristic of the family. It well represents one of the points which brings out the importance of the study of tracheation. In the adult wing (Fig. 1) it might well be taken for a branch of cubitus, but the nymphal wing (Fig. 18) clearly shows that it is not preceded by a trachea. A careful search has been made through hundreds of mounts to establish this point, and no case has yet been found where this condition was not true. On the theory that the principal veins are preceded by trachea while the cross-veins are not, this would prove that the vein in question could not be a part of cubitus.

29. Wings of Insects, p. 249.

The Anal Veins

If the interpretation of the preceding structures has been correct, the remaining veins of the wing must represent the anals. As a matter of fact, this works out very simply and leaves little doubt regarding the homologies of the anal region. It is true that the third anal often shows a forking in the nymphal tracheation (Figs. 5 and 16), but this is of no particular consequence since in a very large number of wings, of which that of the cockroach may serve as an example[30], the anal region has become filled with many veins branching from or posterior to the third anal. In fact, this condition (Fig. 19) homologizes perfectly with the tracheation of this vein in the Cicadidæ[31] which family is as close to the Membracidæ as any whose venation has been determined, and in which, as in the Membracidæ, the specialization has been by reduction. A more significant fact is that this condition is by no means a constant one and should not be considered as typical of the family. In the large majority of cases the anal tracheation is best represented by that shown in Figure 2.

According to this determination, then, the first anal vein arises from the base of cubitus with which stem it has been brought from the main trunk. If this is true, the first anal is very intimately connected with the cubital vein — so intimate, in fact, that it seems almost a misnomer to call it an anal with reference to the Membracidæ — but that it is an anal is shown by the fact that it homologizes with the first anal in the wings of other insects. It represents the claval suture in the fore wing and is in many forms very indistinct in appearance, and the wing is weak along the line which it follows. It is straight and unbranched throughout its course and is connected with no cross-veins. At its tip it unites with cubitus, and the two coalesce to form the marginal limiting vein of the cell M_4. This limiting vein, it must be remarked, is here preceded by three tracheæ, viz. Cu_1, Cu_2 and 1st anal.

Second anal and third anal enter the wing together by a different stem, posterior to that of the cubitus-first anal. They separate at once, forming a large and clearly defined cell, only to coalesce again after about one-third of their course has been

30. Wings of Insects, p. 773.
31. Wings of Insects, p. 249.

traversed (Fig. 20). In this condition they join first anal just before that vein unites with cubitus at its distal end.

This represents the normal procedure. It is not strange to find, however, in a reduced wing, that this region is subject to more variation than that of any of the other veins. In some species, for example, third anal never appears in the adult wing and the cell 2nd A is absent. This has been brought about either by the atrophy of third anal or by its coalescence for an entire instead of a partial length with second anal, the latter explanation being perhaps the more reasonable. Since this condition is found principally in the wings of the smaller species such as *Micrutalis calva*, *Stictocephala lutea*, and *Cyrtolobus vau* (see figures 33, 31, 43) it is probably due to the lack of development of this part of the wing, which causes a crowding of the tracheæ cephalad. In other forms third anal breaks away from second anal after anastomosing for some distance, and sends a very short portion out through the membrane to the margin of the wing. This is found mainly in the larger wings, where there is more surface to be supported, being best seen in the fore wings of *Thelia bimaculata*, *Telemona ampelopsidis*, and *Platycotis sagittata*.

Cross-veins

Of the cross-veins which appear in the fore wing, three only are constant and characteristic of the family, the others being peculiar to certain genera and species and of little comparative importance.

The first of these characteristic cross-veins is found connecting R_{2+3} with R_{4+5}, dividing the cell R_3 at about one-third its length from the point of branching of radial sector. It is fairly constant, but it does not appear in the genera Acutalis or Micrutalis in so far as representatives of these genera have been studied. In the figured wing of *Ophiderma pubescens* q. v., this cross-vein is forked, a condition which is of course abnormal.

The second is equally constant but surprisingly variable in position. It appears between media and cubitus, usually in the basal third of the wing, but often shifts from a position close to the base of these veins (cf. *Ceresa diceros*) to one so far toward the tip of the wing that in the case of *Smilia camelus* (see figure) it has actually moved off of cubitus and its posterior end rests on the other cross-vein which connects Cu with M_{3+4}.

Thus it is the most unreliable cross-vein so far as position is concerned, which is found in the wing. In a few species it does not appear. In *Archasia belfragei*, media and cubitus dip toward and touch one another at the point where this vein is typically found. In *Entylia bactriana*, which is an interesting wing in other respects also, media and cubitus anastomose for such a distance as to make this vein unnecessary. The same is true of *Publilia concava*. In certain forms this vein varies within a species. The figures shown of *Thelia bimaculata* and *Carynota mera* show two cross-veins at this point, but this is only occasionally found even in those species.

The third constant cross-vein is that connecting M_{3+4} with Cu. It varies in length from a mere attachment, as in *Entylia bactriana*, to the prominent and important position which it assumes in most of the wings of the family. No membracid wing has been examined in the course of this study which did not show this cross-vein, and as has been suggested in the consideration of cubitus, it has been particularly noted as being an apparent part of that vein.

Other cross-veins are found, but with no regularity and of no especial significance. R_{4+5} occasionally does not unite with M_{1+2} and a cross-vein bridges over (e. g. *Platycotis sagittata*). M_{3+4} sometime moves so far from M_{1+2} that this part of the wing has been strengthened in the same manner and one species at least has added cross-veins to such an extent that the actual condition of the typical form is only conjectural from the material at hand. This species is *Phylia ferruginosa*, the species possessing the most unusual cross-veining of any Membracid studied.

The tracheation of the wing-base

In their basal structure the wings of the Membracidæ refuse to agree exactly in structure with those of closely related families, and if the determination of homologies in this study is correct, they more nearly approach the hypothetical type than do any of the other Hemiptera.

It has been shown in the wing of the Cicada[32] that all the tracheæ in the wing arise from one main trunk[33]. In the closely related family of Membracidæ it would naturally be

32. Wings of Insects, pp. 243–249.
33. Wings of Insects, p. 244, Fig. 14 and the accompanying discussion.

supposed that this important feature would also hold true, but this appears not to be the case. Instead, the tracheæ arise from two main trunks, the most anterior of which gives rise to costa, subcosta, radius and media, while the other furnishes the origin of cubitus and the anals.

The two trunks come from the thorax at different angles, and so far as has been observed, are never united (Fig. 21). This does not prove, to be sure, that the connection never occurs, but it would seem that in the study of a very large number of nymphal wings the connection would sometimes have appeared if it were present. On the contrary, the study of a long series of wings of many genera and species seems to show that in this particular family the original hypothetical type of two main trunks has been preserved and that in this respect at least, the Membracidæ can be said to be the most generalized of the Hemiptera, being more conservative in this particular than even the Cicada.[34]

Marginal Veins

The scalloped appearance given to the venation by the marginal vein inside the membrane, is characteristic. The extremities of the longitudinal veins are connected by strong regular veins which form a smooth edge for the veined portion of the wing (Fig 1). The origin of this structure is explained by the manner in which the ends of the longitudinal tracheæ branch and overlap when they reach the region under consideration (Fig. 22). Since the reduction of the wing has left at the tip branches of radius two-plus-three, radius four-plus-five, media one-plus-two, media three-plus-four and cubitus one-plus-two which have not entirely coalesced, it is natural that these tracheæ, which have probably in the wing of past times represented separate veins, should remain more or less distinct. This has happened, and the wing tip shows that these tracheæ tend to pull apart and run along the marginal lines (Fig. 23). It seems rather remarkable that any of these tracheæ should ever actually turn backward, but such is the case. The normal method is as follows: subcosta continues along the cephalic margin to the extreme tip of the wing; R_1 unites with subcosta

34. Comstock and Needham state, "The conservative Hemiptera that retain most perfectly the fashions of ancient times so far at least as concerns the venation of the wings, are the cicadas."—Wings of Insects, p. 243.

from the point of its coalescence outward; R_2 turns upward to meet Sc plus R_1; R_3 turns outward and downward and coalesces with the tip of R_4; R_4 turns upward to unite with R_3; R_5 continues outward to touch the end of M_1; M_1 bends upward to R_5; M_2 turns backward to unite with the tip of M_3; M_3 continues forward to meet M_2; M_4 also turns backward to meet the tracheæ of Cu_{1+2} and 1st A which have continued outward, and the tips of the other tracheæ have proceeded distad in their natural position, extending to points which enable them to coalesce with the tracheæ ahead.

In this way a strong marginal vein has been formed along the lines laid down by these tracheæ which is as strong and sometimes stronger than the longitudinal veins themselves, since it contains at various places in its course, the tips of two, three, and sometimes even four tracheæ.

Variation

This study would be incomplete if some mention were not made, in the consideration of the fore wing, of the variations which often occur. The venation which has been outlined has been in the main that of the normal structure. Considerable variation occurs, however, often within a species, and this deserves some mention.

The wing of *Thelia bimaculata* has been chosen as an illustration because this species shows perhaps the greatest range of variation found in any one species. In the diagram shown (Fig. 24) the dotted lines represent the maximum variation, and all stages between the normal and this maximum may be found. It will be noted that R_1 sometimes leaves radius two-plus-three at a point very close to the fork of radial sector. This would represent a less specialized condition than the normal. R_{4+5} and M_{1+2} sometimes approach each other with a wide curve and barely touch, instead of coalescing in the usual manner, and this does away with the sharp bend of M_{1+2}. M_3 and M_4 are occasionally separate, forming an additional cell M_3. As might be supposed from the discussion of the cross-veins, that one between media and cubitus shows the greatest irregularities. It ranges from the most proximal position shown by the dotted lines at the left, to one very close to the point at which media branches, and in some cases even disappears altogether, media and cubitus bending toward and touching each other.

Such variation as this is not uncommon in the Membracidæ. For this reason it would seem that taxonomic characters based on the shape, size and number of cells should not be attached with the greatest importance unless it can be clearly proven that these irregularities do not occur in the forms in question.

It may be mentioned in passing, that *Thelia bimaculata* shows also a great variation in the length of the pronotal horn. An attempt has been made to compare this variation with that of the wing but the results were negative, and the variation of the two structures seems to be entirely independent.

THE HIND WING

As has been stated (p. 81) the hind wing in the Membracidæ has more nearly kept pace with the fore wing in specialization than is usually the case in Hemiptera. An interpretation, therefore, of the fore wing leaves little to be determined so far as homologies are concerned and in fact the venation, after the tracheation has been worked out, is almost self-evident. In the hind wing the reduction has gone further than in the fore wing as is shown in the nymphal tracheation (Fig. 25). The tracheæ for costa and subcosta have disappeared. The wing, however, shows a thickening or ridge along the cephalic margin which is probably due to subcosta or perhaps in some cases to costa-plus-subcosta, although the preceding tracheæ are not distinguishable and the vein itself not prominent. Radius behaves much as in the fore wing. The trachea is apparently two-branched but high magnification shows that R_1 is present, running close to R_{2+3} (Fig. 26). Occasionally also, R_1 upon reaching the margin of the wing turns backward to meet the costal thickening so that in some cases the point at which costa-plus-subcosta unites with R_{2+3} represents what remains of R_1 (Fig. 27). The most important point of difference between the two wings is found in the cross vein r-m connecting R_{4+5} with M_{1+2}. This difference has been noted by Redtenbacher in his explanation of the hind wing of *Centrotus cornutus*[35] the only Membracid which he figures and which happens to show this character. In the fore wing these longitudinal veins (R_{4+5} and M_{1+2}) usually anastomose. In the hind wing

35. Redtenbacher, Josef. Vergleichende Studien uber das Flugelgeader der Insecten, Ann. k. k. Naturh. Hofmus. I, 1886, p. 187.

they are often some distance apart and connected by a strong cross-vein.[36] The explanation to the disappearance of costa and subcosta which causes this condition — which is of course the more generalized one — is probably that the median part of the wing, having an advantageous blood supply, has developed to such an extent as to crowd the cephalic region, causing radius to move over into that part of the wing usually occupied by costa and subcosta, and forcing these tracheæ out of existence.

Media is typical (Fig. 28), branching in about the center of the wing into M_{1+2} and M_{3+4} which continue their respective courses toward the tip, there to turn along the marginal line as in the fore wing.

Cubitus likewise presents the same condition that it does in the fore wing (Fig. 29). At times the tracheæ representing Cu_1 and Cu_2 respectively may be traced side by side for some distance back into the wing, but in no case do they separate.

First anal differs from the front wing in being stronger and not paralleling the suture. The wing membrane at this point in the hind wing is smooth and firm.

Second and third anals are usually coalesced to form one vein in the adult hind wing, although the individual tracheæ are to be seen in the nymphal structure. Occasionally these two veins separate to form the cell 2nd A as in *Ceresa bubalus*.

This is the normal venation. Some slight modifications can be found in a few genera. In *Smilia*, *Cyrtolobus*, *Xantholobus*, *Ophiderma*, and others, the characteristic cross-vein between R_{4+5} and M_{1+2} is lacking, these two veins anastomosing as in the front wing. In other respects the hind wings vary far less among the genera and species than in the fore wing, even in minor details. In many cases they are identical and it has been hard to find forms with differences marked enough to be worth figuring. It will be remarked in the figures that in shape and general appearance the agreement is quite noticeable.

36. See figures of *Carynota mera*, *Thelia bimaculata*, *Glossonotus crataegi*, *Telemona ampelopsidis*, *Archasia belfragei*, and *Heliria scalaria*.

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The paper which has been the principal basis for this study and which has been a source of constant inspiration throughout the work, is Comstock-Needham's "Wings of Insects," published in the American Naturalist, Vols. XXXII and XXXIII, 1898 and 1899. Other publications and texts used are the following:

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FIGURES.

The figures of nymphal wings, and the diagrams used, are arbitrarily arranged in the order in which reference is made to them in the text, without respect to relationship of species.

The figures of adult wings are arranged according to subfamilies to facilitate reference. The order of subfamilies is based on Van Duzee's "Studies in North American Membracidae."

The following is the explanation of the figures in order:

Nymphal wings and diagrams.

Fig. 1. Fore and hind wings of Thelia bimaculata.
Fig. 2. Fore wing nymph—Thelia bimaculata.
Fig. 3. Fore wing nymph—Thelia bimaculata, showing costa.
Fig. 4. Fore wing nymph—Telemona ampelopsidis, showing costa.
Fig. 5. Fore wing nymph—Ceresa borealis, showing costa.
Fig. 6. Fore wing nymph—Vanduzea arquata, showing costa.
Fig. 7. Fore wing nymph—Vanduzea arquata, showing base of costa.
Fig. 8. Diagram showing typical radius.
Fig. 9. Fore wing nymph—Vanduzea arquata, showing R_1.
Fig. 10. Highly magnified portion of fore wing nymph of Vanduzea arquata, showing region of R_1.
Fig. 11. Highly magnified portion of fore wing nymph of Telemona ampelopsidis, showing region of R_1.
Fig. 12. Fore wing nymph—Enchenopa binotata, showing R_1.
Fig. 13. Fore wing nymph—Ceresa diceros, showing media and the coalescence of R_{4+5} with M_{1+2}.

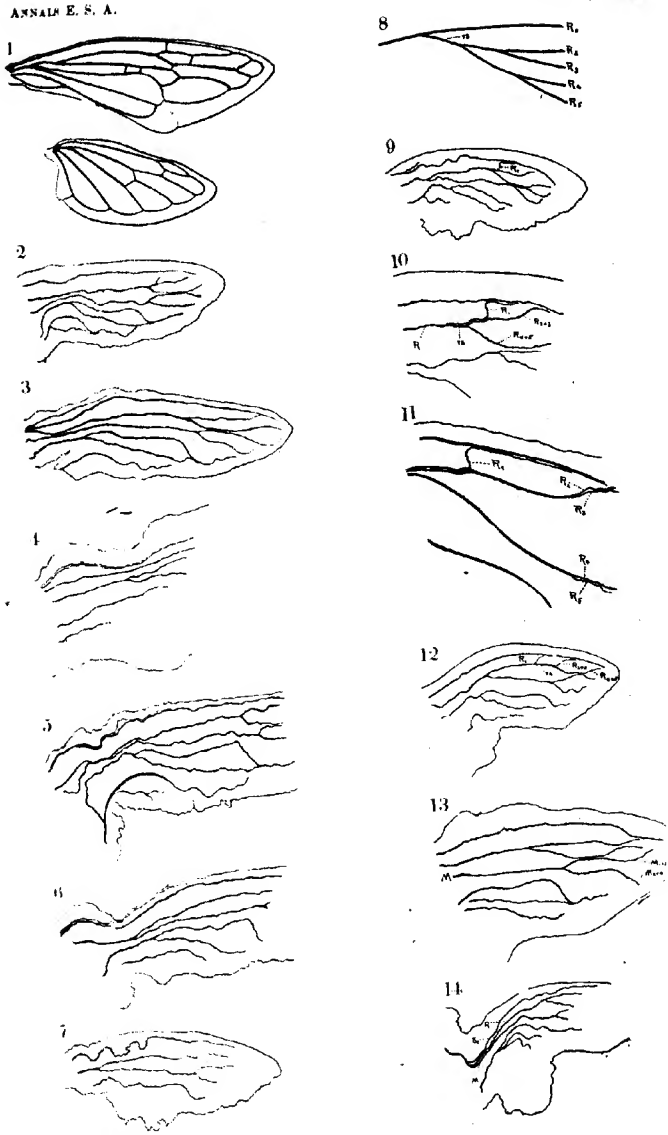
Fig. 14. Base of fore wing nymph—Ceresa diceros, showing origin of media.
Fig. 15. Base of fore wing nymph—Thelia bimaculata.
Fig. 16. Fore wing nymph—Ceresa bubalus, showing anals.
Fig. 17. Fore wing nymph—Ceresa diceros, showing cubitus.
Fig. 18. Fore wing nymph—Thelia bimaculata, showing cross-vein.
Fig. 19. Fore wing nymph—Telemona ampelopsidis, showing anals.
Fig. 20. Fore wing nymph—Vanduzea arquata, showing 2nd and 3rd anals.
Fig. 21. Base of fore wing nymph—Thelia bimaculata, showing basal tracheation.
Fig. 22. Fore wing nymph—Ceresa bubalus, showing branches of longitudinal veins.
Fig. 23. Diagram of tracheation in tip of fore wing, showing formation of marginal vein.
Fig. 24. Diagram of variations in wing of Thelia bimaculata.
Fig. 25. Hind wing nymph—Thelia bimaculata.
Fig. 26. Highly magnified portion of hind wing nymph of Thelia bimaculata showing region of R_1.
Fig. 27. Diagram showing position of the remains of R_1 in hind wing.
Fig. 28. Hind wing nymph—Vanduzea arquata, showing media.
Fig. 29. Hind wing nymph—Ceresa diceros, showing cubitus.

Adult fore wings.

Fig. 30. Ceresa bubalus.
Fig. 31. Stictocephala lutea.
Fig. 32. Acutalis tartarea.
Fig. 33. Micrutalis calva.
Fig. 34. Micrutalis dorsalis.
Fig. 35. Carynota mera.
Fig. 36. Thelia bimaculata.
Fig. 37. Glossonotus crataegi.
Fig. 38. Telemona ampelopsidis.
Fig. 39. Telemonanthe pulchella.
Fig. 40. Archasia belfragei.
Fig. 41. Heliria scalari.
Fig. 42. Smilia camelus.
Fig. 43. Crytolobus vau.
Fig. 44. Atyma castaneae.
Fig. 45. Xanthlobus trilineatus.
Fig. 46. Ophiderma pubescens.
Fig. 47. Vanduzea arquata.
Fig. 48. Entylia bactriana.
Fig. 49. Publilia concava.
Fig. 50. Stictopelta marmorata.
Fig. 51. Platycotis sagittata.
Fig. 52. Campylenchia curvata.
Fig. 53. Enchenopa binotata.
Fig. 54. Tylopelta gibberata.
Fig. 55. Phylia ferruginosa.
Fig. 56. Centruchoides perdita.
Fig. 57. Platycentrus acuticornis.

Adult hind wings.

Fig. 58. Ceresa bubalus.
Fig. 59. Carynota mera.
Fig. 60. Thelia bimaculata.
Fig. 61. Glossonotus crataegi.
Fig. 62. Telemona ampelopsidis.
Fig. 63. Archasia belfragei.
Fig. 64. Heliria scalari.
Fig. 65. Smilia camelus.
Fig. 66. Cyrtolobus vau.
Fig. 67. Xantholobus trilineatus.
Fig. 68. Ophiderma pubescens.
Fig. 69. Vanduzea arquata.
Fig. 70. Stictopelta marmorata.
Fig. 71. Platycotis sagittata.
Fig. 72. Campylenchia curvata.
Fig. 73. Enchenopa binotata.
Fig. 74. Centruchoides perdita.



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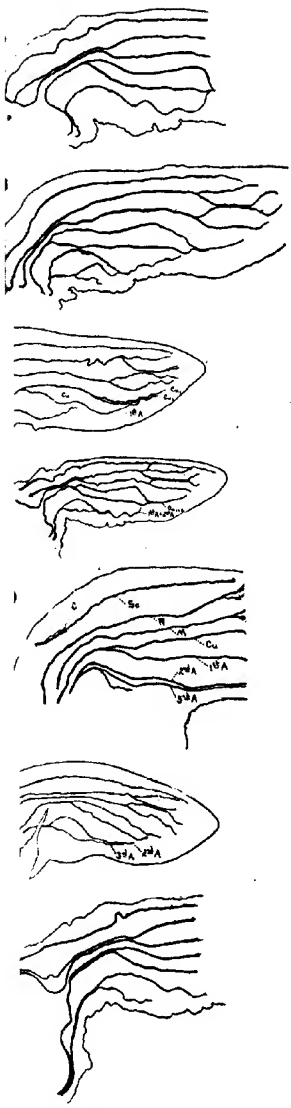

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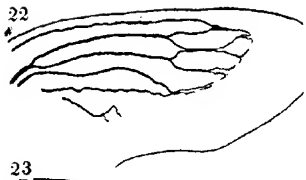

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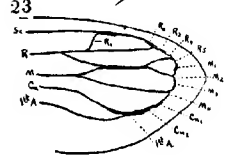

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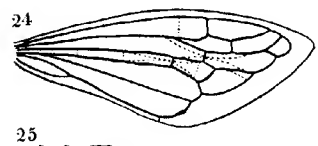

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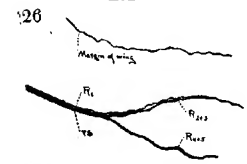

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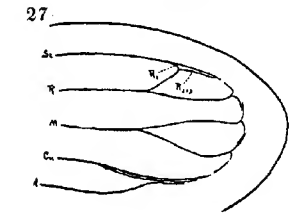

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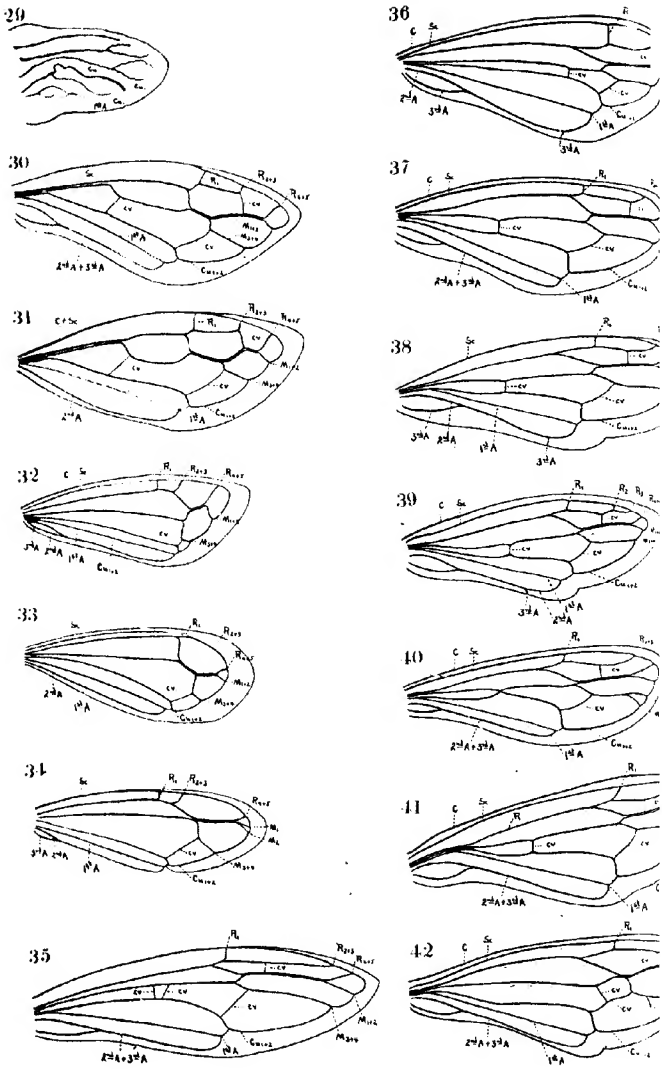

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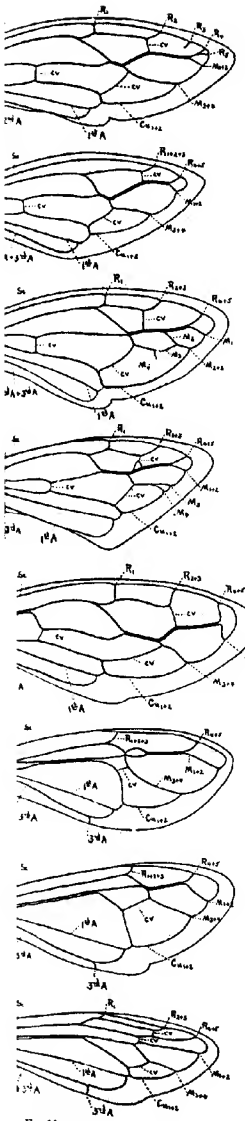

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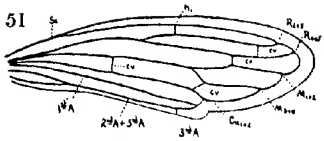

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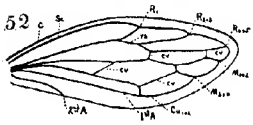

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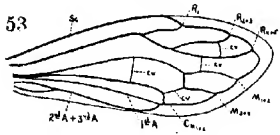

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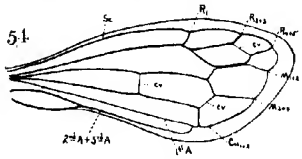

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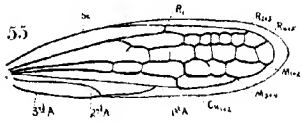

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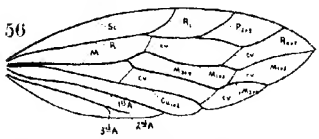

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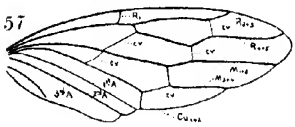

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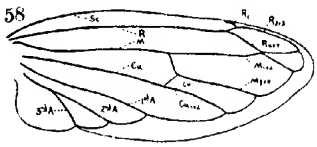

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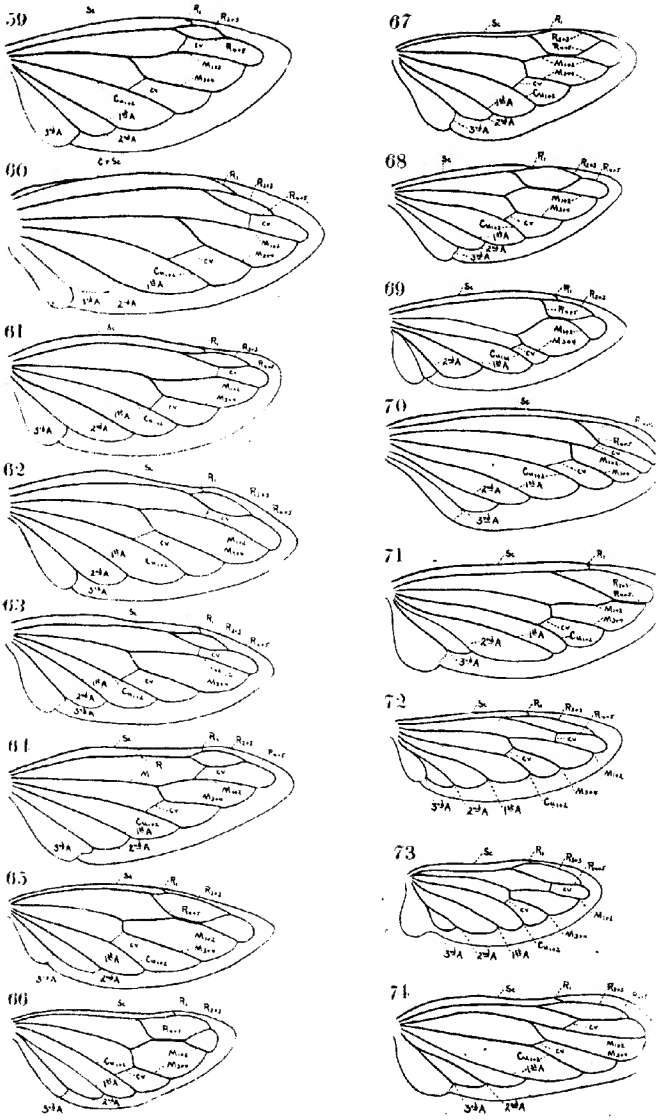

W. D. Funkhouser.

THE WING VENATION OF THE JASSIDAE.

Z. P. METCALF.

The present paper was undertaken several years ago at the suggestion of Professor Herbert Osborn. At that time it was thought that the wing veins of Homopterous insects could be identified in the adult stage by carefully comparing them with the venation of the Cicadidæ as determined by Comstock and Needham '98–'99. This, however, was found to be impracticable as it was soon discovered that the wing veins of most of the Homoptera have been greatly reduced and much modified from the Cicadid type. The study was then discontinued until the spring of 1910, when it was resumed by studying it from the standpoint of the nymphal wing pads.

At first the wing pads were removed as carefully as possible and mounted in glycerine jelly, as recommended by Comstock and Needham '98–'99. Later on many wing pads were mounted in xylene damar as recommended by Miss Patch '09. It was soon discovered, however, that just as good results could be obtained by mounting the wing pads in water. These wing pads were then either photographed or drawn with the aid of the camera lucida. For most Jassidæ it was found more satisfactory to draw them with the camera lucida. This is due to the fact that the outer covering of the wing pad is very thick and frequently dark colored. In addition many of the wing pads were so thick that, using the high powers necessary, it was found to be impossible to bring all parts of all the tracheæ into sharp focus at the same time. This lead to some confusion as many of the wing pads are provided with long spines which make the interpretation of the tracheæ difficult, as many of the spines are so placed as to appear in photographs as branches of the tracheæ which are slightly out of focus.

After the drawings were finished they were carefully compared many times over with wing pads from nymphs collected at later dates. If any marked differences were noted drawings were made and these again compared with the pads from nymphs collected at later dates. In this way, it is believed that all errors that might arise have been corrected or eliminated. The nymphal wing pads shown in the plates have been carefully selected from these drawings or redrawn from photographs.

The adult wings shown have been drawn with the aid of the Edinger drawing apparatus and have been selected, for the most part, from adults showing the normal venation. In a few cases, however, wings have been used which show the presence of unusual cross veins or the absence of usual cross veins.

In spite of the fact that many different methods of mounting were tried, several genera did not yield satisfactory mounts. The most conspicuous genera, in this respect, were *Kolla* and *Tettigoniella*. In spite of the fact that several hundred wing pads of these two genera were mounted from specimens collected from early spring to late summer, no satisfactory mounts were secured. Certain species in other genera show this same characteristic. Perhaps the most conspicuous species, in this respect, is *Diedrocephala versuta* Say. Nymphs of this species can be found in great numbers at Raleigh, North Carolina, throughout the season. Yet in spite of the fact that they were collected in large numbers and treated in many different ways no satisfactory wing pads of *Diedrocephala versuta* have been secured.

It is also necessary to secure the nymphs at the proper time. Some little time before the insect molts, the wing is very much crumpled in its sheath. This is especially true of the last molt. This is unfortunate as, in many cases, the older wing pads are necessary for determining the homologies of some of the tracheæ and veins. As already pointed out by Comstock and Needham '98-'99 the best results can be secured by selecting the paler colored individuals.

In all twenty-five genera of *Jassidæ* have been studied in the preparation of this paper. These genera represent such forms as could be readily secured in the vicinity of Raleigh, North Carolina. They contain representatives of all of the subfamilies and tribes of *Jassidæ* commonly found in Eastern North America.

In the course of this study many hundreds of nymphs have been collected and their wing pads studied. It has not always been found possible to remove the wing pads so as to secure the body tracheæ. The writer does not consider this important, however, as all of the pads have been removed close enough to the base to assure him of the homologies of the principal tracheæ.

This paper is founded upon the work of Comstock and Needham '98–'99. It adopts the same system they propose for naming the veins and for naming and numbering the cells, as the writer believes that this system is the only logical one that has been offered. An attempt made to homologize the veins of adult *Homoptera* and a subsequent study of the tracheation that precedes venation, has thoroughly convinced the writer that the Comstock-Needham system is the only logical one.

THE FORE WING.

The type of the fore wing of *Jassidæ* is fairly uniform but in order to point out the difference that exists the tracheæ will be considered in detail beginning at the costal margin.

The wings of *Jassidæ* show marked specialization by reduction. This reduction is usually accompanied by the atrophy of one of the branches of one of the main tracheæ and the shifting of a branch of a neighboring trachea until it occupies the region of the atrophied trachea. This is well illustrated in the atrophy of M_{1+2} of the fore wing which is discussed below. Another excellent example of the same thing is found in the *Typhlocybidæ* where M_{3+4} occupies the region usually traversed by Cu_1. The atrophy of these tracheæ with the subsequent shifting of other tracheæ which take their places gives to the wings of the *Jassidæ* their characteristic aspect.

THE COSTA OF FORE WING.

The costal trachea is absent in all of the Jassid wings that have been examined with the exception of *Gypona* (Fig. 8). Here the costal trachea is long being almost as long as subcosta and running parallel with it throughout its length. In no other Jassid was any trace of Costa found. In all cases the nymphal pad was removed as near the base as possible and the body trachea was examined for traces of the costal spur but no trace of such spur was found. This was due to the fact, perhaps, that it is impossible to get any great length of the body trachea in such a dissection. In a few cases, however, a considerable length of the body trachea was secured (Figs. 3, 5, 62, 64). This indicates that Costa has practically disappeared from the *Jassidæ*.

THE SUBCOSTA OF THE FORE WING.

The subcostal trachea in the *Jassidæ* is very anomalous. It reaches its greatest length, in the genera examined, in the genus *Jassus* (Fig. 60), where it passes beyond the apex of the wing and replaces R_2 and R_3 in the ambient vein. Subcosta is slightly shorter in *Gypona* (Fig. 8), of about the same length in *Spangbergiella* (Fig. 20), also in *Agallia* (Fig. 1). In *Acinopterus* (Fig. 41) it is still shorter barely reaching R_2. In *Platymetopius* (Fig. 26) it is about half the length of the main stem of Radius. No further evidence of the presence of Subcosta was found although the Subcostal vein on the border of the wing is well developed in all of the adult wings which the writer has examined and it shows very clearly as a distinctly lighter area in all the older nymphs examined. This series undoubtedly shows how the subcosta has atrophied in Jassidæ.

THE RADIUS OF THE FORE WING.

The radial trachea in the fore wing of *Jassidæ* is typically two-branched although in some forms three and even four branches do occur. The two branches of the typical radius represent R_{2+3} and R_{4+5}. R_1 has almost completely disappeared from the fore wings of the *Jassidæ*. It does occur, as a delicate branch, in a few genera but gives rise to a very characteristic cross vein between subcosta and radius which is known currently as the "nodal vein". The nodal vein, however, is a very anomalous one and its characters will be discussed later. R_1 has been found in the following widely separated genera, *Oncometopia* (Fig. 3), *Scaphoideus* (Fig. 44) and *Typhlocyba* (Fig. 64). In other genera there remains a distinct cross vein connecting subcosta with the main stem of radius, or subcosta with R_{2+3}. This vein, which is usually referred to as the nodal vein, undoubtedly represents the remnant of R_1 or R_2. Or it may be considered as a vein which merely followed a weak lateral branch of R or R_{2+3}, which either happened to be connected with the main stem of radius, when it resembles R_1, or it may have happened to be connected with R_{2+3} in that case it resembles R_2. The writer is inclined to think that this is a distinct vein representing in some cases R_1 and in others R_2.

Trachea R_1 is very conspicuous in *Oncometopia* (Fig. 3), *Scaphoideus* (Fig. 44) and *Typhlocyba* (Fig. 64). The resulting

cross vein is attached to radius in some species of *Scaphoideus* (Fig. 53) and in *Typhlocyba* (Fig. 77), but in *Oncometopia* the resulting cross vein is sometimes absent in the adult wing, and is sometimes present as a fairly strong cross vein uniting with radius near the point where it branches into R_{2+3} and R_{4+5}. In other cases, it appears as a fairly strong cross vein distinctly uniting subcosta with R_{2+3}. The whole question seems to be settled by reference to figure 3 which was taken from a half grown nymph. This wing pad shows a weak R_1 which runs parallel to R_{2+3} for a considerable distance and then bends toward the costal margin. All attempts to secure older nymphs whose wing pads would show the forming veins along the tracheæ failed owing to the thickness of the pads and the large amount of coloring matter. Inasmuch as trachea R_1 does run parallel with R_{2+3} for some distance it would seem to indicate that the point of attachment of the cross vein which follows the trachea might be at any one of various points along the radial vein over a considerable length of that vein.

In other cases this cross vein is very evidently R_2. It appears as a weak lateral branch of R_{2+3} in *Parabolocratus* (Fig. 23), as a somewhat stronger branch in *Goniagnathus* (Fig. 25), as a still stronger branch in *Phlepsius* (Fig. 48). In *Acinopterus* (Fig. 41) the trachea gradually diverges but the forming vein is set at nearly a right angle to R_{2+3}. In *Jassus* (Fig. 60) trachea R_2 reaches its greatest size for any of the genera examined and the vein in the adult wing seems to follow the course of the trachea rather closely. In *Chlorotettix* (Fig. 43) tracheæ R_2 and R_3 are united for nearly their entire length, being separated only at their tips. This character seems to be comparatively constant for the genus (Fig. 52). In still other genera the nodal cross vein is formed without being preceded by any trachea. This is especially conspicuous in certain species of *Draeculacephala* (Fig. 6) which have only one cross vein connecting subcosta with R_{2+3}. In *Eutettix* (Fig. 46) two cross veins are formed, one occupying the position of R_1 and the other the position of R_2. Neither one of these cross veins is preceded by a trachea. There is an interesting question involved in the genus *Scaphoideus*. As pointed out by Osborn '00 the nodal vein arises from radius in *auronitens* and certain other species while in *jucundus* and allied species it arises from R_{2+3}. Unfortunately the writer was able to secure nymphs of

only the first group but he believes that the nodal cross vein in the *jucundus* group is the untracheated cross vein between R_1 and R_3 (Fig. 44). In this case the nodal cross vein in *Scaphoideus* would be R_1 when the "nodal vein arises from discal cell" and R_2 when the "nodal vein arises from anteapical cell".

In most of the genera of the *Jassidæ* radius branches once and only once, the resulting branches being R_{2+3} and R_{4+5} (Figs. 1, 5, 6, 20, 22, 26, 28, 62). In several cases referred to above R_2 separates from R_3. In only one genus examined, *Eutettix* (Fig. 46) has R_1 and R_5 been found separated. In this case R_1 occurs as a cross vein between R_{2+3} and R_5. R_{2+3} is much atrophied and R_1 extends to the margin traversing the region usually occupied by R_{2+3}. In a single genus examined, *Empoasca* (Fig. 66), radius extends as a single unbranched trachea from the base of the wing pad to the apex. Although in the adult wing, in many cases, there is a cross vein connecting radius with the margin of the wing.

MEDIUS OF THE FORE WING.

Medius in the *Jassidæ* is typically two-branched. These branches embrace M_1 and M_2, and M_3 and M_4 respectively. M_{1+2} is well developed in *Chlorotettix* (Fig. 43) where it runs parallel to R_{4+5}. It is not so well developed in *Parabolocratus* (Fig. 23) *Platymetopius* (Fig. 26) and *Gypona* (Fig. 8). In *Deltocephalus* (Fig. 28) M_{1+2} is reduced to a mere spur. In the other genera studied medius consists of a single unbranched trachea which extends from the base to the apex of the wing pad, although in most cases there is a strong transverse vein connecting medius with R_{4+5}. The writer believes that the above series, as outlined, represents fairly well the development of medius from a two-branched condition to a single unbranched trachea. If this conception be correct M_{1+2} must have come to lie parallel with R_{4+5} and has been gradually reduced until the present time it is at most merely a cross vein connecting medius with R_{4+5}. The vein having persisted in some cases notwithstanding the fact that the trachea has been lost. This is especially evident in *Agallia* (Fig. 1), *Scaphoideus* (Fig. 44) and *Eutettix* (Fig. 46).

In the *Typhlocybidæ* (Fig. 64 and 66) medius is very evidently two branched. In *Typhlocyba* (Fig. 64) R_{4+5} is greatly reduced

and resembles a cross vein. The usual position of R_{4+5} is occupied by M_{1+2}. In *Empoasca* (Fig. 66) Rs coalesces with M_{1+2} for a short distance and then diverges toward the costal border M_{3+4} being very distinct.

CUBITUS AND FIRST ANAL OF THE FORE WING.

In all of the genera of *Jassidæ* examined the cubital and first anal tracheæ were the most constant and formed one of the best landmarks in the study of the relations of the tracheæ. They are coalesced for some little distance from the base of the wing.

Cubitus is frequently two branched (Figs. 8, 22, 23, 25, 43, 48, 60). Here again we can trace almost a complete series from a form like *Jassus* (Fig. 60) or *Goniognathus* (Fig. 25), where Cu_2 is equally as important as Cu_1, through intermediate forms like *Gypona* (Fig. 8), to forms like *Phlepsius* (Fig. 48) where Cu_2 is reduced to a mere spur.

In the *Typhlocybidæ* (Fig. 64 and 66) M_{3+4} has come to occupy the region usually occupied by Cu_1 and cubitus is unbranched and diverges strongly toward the anal border which gives it the appearance of having lost branch Cu_1 and having retained Cu_2.

The first anal vein lies along the anal border of the claval suture. It has not been usually recognized as a distinct vein owing to the fact that as a vein it is rather inconspicuous while the claval suture or fold is very distinct. It is, however, preceded by a conspicuous trachea in all of the genera studied.

SECOND AND THIRD ANALS OF THE FORE WING.

The second and third anal tracheæ in the fore wing are well developed and the third anal is frequently two branched (Figs. 3, 5, 6, 20, 23, 25, 41, 46, 60).

THE HIND WING.

In all of the *Jassidæ* proper the hind wing is very uniform. No costal or subcostal tracheæ have been discovered although the subcostal vein was well defined in all of the older nymphs studied (Figs. 9, 24, 45, 47).

RADIUS OF THE HIND WING.

The radius is typically two branched in the hind wing of the *Jassidæ*. Several mounts of *Spangbergiella* (Fig. 21) failed to reveal anything but a single unbranched radial trachea. In the adult hind wing (Fig. 35) there is faint indication of a vein in the position usually occupied by R_{2+3}.

R_{2+3} reaches its greatest development in *Draeculacephala* (Fig. 7) where it forms the tracheæ that precedes the whole of the ambient vein. In many forms, however, it is very much atrophied (Figs. 24, 45, 47, 65) while in *Empoasca* (Fig. 67) the radius is a simple unbranched trachea. The radius of the *Typhlocybidæ* coalesces for a considerable distance with M_{1+2} (Figs. 65 and 67).

MEDIUS OF THE HIND WING.

Medius of the hind wing is two branched in all of the genera that have been examined. In the *Typhlocybidæ*, however, M_{1+2} coalesces with radius for some distance and M_{3+4} coalesces with cubitus for almost its entire length so as to appear as a cross vein in the adult wing connecting medius with cubitus (Fig. 80). In the other genera studied M_{1+2} is connected with R_{4+5} by a short cross vein and M_{3+4} is connected with cubitus by a similar short cross vein. In some cases the latter cross vein is greatly reduced and in Jassus (Fig. 69) R_{4+5} and M_{1+2} coalesce for a short distance and again separate before reaching the margin of the wing.

In all of the genera studied cubitus is a single unbranched trachea in the hind wing. Its relations with medius in the *Typhlocybidæ* have already been discussed. As in the fore wing, cubitus and first anal are very closely united. Second and third anal are also present in nearly all cases and third anal is frequently two branched. The second anal and the anterior branch of the third anal generally coalesce for a considerable distance near the middle of their course and are usually separated again near the base of the wing (Figs. 16, 38, 57). There is always a conspicuous fold just posterior to the anterior branch of the third anal.

HISTORICAL DISCUSSION.

A comparison of the nomenclature here suggested with the nomenclature current in America and with the nomenclature as suggested by Edwards '94–96 is given in the subjoined table.

NOMENCLATURE OF VEINS

TERMINOLOGY SUGGESTED	AFTER EDWARDS	CURRENT TERMINOLOGY
Subcosta		Costal border
R+M	Cubital	First sector
Radius	Upper branch of cubital	Outer branch of first sector
R_1		Nodal
R_2	Angular	Nodal
R_{2+3}		Anterior branch of outer sector
R_3		
R_{4+5}		Posterior branch of outer sector
R_4		
R_5		
Medius	Lower branch of cubital	Inner branch of first sector
M_{1+2}		
M_{3+4}		
Cubitus	Brachial	Second sector
Cu_1		
Cu_2		
Anal furrow	claval suture	claval suture
First Anal		
Second anal	anal	outer claval
Third anal	axillary	inner claval
Ambient		

NOMENCLATURE OF THE CELLS

TERMINOLOGY SUGGESTED	AFTER EDWARDS	CURRENT TERMINOLOGY
Subcosta	costal	
Radius	subcosta	
R_1		
R_2	Apical	apical
First R_3	subapical	anteapical
Second R_3	apical	apical
First R_5	apical	anteapical
Second R_5	apical	apical
First Medius	basal	
Second Medius	superbrachial	
First M_4	Subapical	anteapical
Second M_4	apical	apical
Cubitus	brachial	
Cu_1	apical	apical

SUMMARY.

The present paper homologizes the wing veins of *Jassidæ* with the wing veins of other orders. The wing veins of *Jassidæ* differ in the following important respects from those of other insects.

1. The costal trachea is practically eliminated from the wings of *Jassidæ*.

2. The subcostal trachea is well developed in some genera and absent in others, which indicates that it is disappearing from *Jassidæ*.

3. The radial trachea is typically two branched in *Jassidæ*, the branches present being R_{2+3} and R_{4+5}.

4. The medial treachea is typically two branched, these branches being M_{1+2} and M_{3+4}.

5. The cubital trachea is two branched in some cases and unbranched in others.

6. All three anal trachea are present, the first anal being very closely connected with cubitus. Third anal is frequently two branched.

7. The ambient vein is a composite vein in *Jassidæ*, being formed along the overlapping tips of the principal trachea.

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EXPLANATION OF PLATES.

PLATE VIII.

Fig. 1. Fore wing pad of *Agallia 4-punctata* Prov.
" 2. Hind " " *Agallia 4-punctata* Prov.
" 3. Fore " " *Oncometopia undata* Fabr.
" 4. Hind " " *Oncometopia undata* Fabr.
" 5. Fore " " *Diedrocephala coccinea* Forst.
" 6. Fore " " *Draeculacephala mollipes* Say.
" 7. Hind " " *Draeculacephala mollipes* Say.
" 8. Fore " " *Gypona 8-lineata* Say.
" 9. Hind " " *Gypona 8-lineata* Say.

PLATE IX.

Fig. 10. Fore wing of *Agallia constricta* Van Duzee.
" 11. Hind " *Agalia constricta* Van Duzee.
" 12. Fore " *Oncometopia undata* Fabr.
" 13. Hind " *Oncometopia undata* Fabr.
" 14. Fore " *Diedrocephala coccinea* Forst.
" 15. Fore " *Draeculacephala mollipes* Say.
" 16. Hind " *Draeculacephala mollipes* Say.
" 17. Fore " *Penthimia americana* Fitch.
" 18. Fore " *Gypona 8-lineata* Say.
" 19. Hind " *Gypona 8-lineata* Say.

PLATE X.

Fig. 20. Fore wing pad of *Spangbergiella vulnerata* Uhler.
" 21. Hind " " *Spangbergiella vulnerata* Uhler.
" 22. Fore " " *Athysanus* sp.
" 23. Fore " " *Parabolocratus viridis* Uhler.
" 24. Hind " " *Parabolocratus viridis* Uhler
" 25. Fore " " *Goniagnathus palmeri* Van Duzee.
" 26. Fore " " *Platymetopius* sp.
" 27. Hind " " *Platymetopius* sp.
" 28. Fore " " *Deltocephalus* sp.
" 29. Hind " " *Deltocephalus* sp.

PLATE XI.

Fig. 30. Fore wing *Xerophloea viridis* Fabr.
" 31. Fore " *Spangbergiella vulnerata* Uhler.
" 32. Hind " *Athysanus exitiosus* Uhler.
" 33. Fore " *Athysanus exitiosus* Uhler.
" 34. Fore " *Parabolocratus viridis* Uhler
" 35. Hind " *Spangbergiella vulnerata* Uhler.
" 36. Fore " *Goniagnathus palmeri* Van Duzee.
" 37. Fore " *Platymetopius* sp.
" 38. Hind " *Platymetopius* sp.
" 39. Fore " *Deltocephalus obtectus* O. & B.
" 40. Hind " *Deltocephalus obtectus* O. & B.

PLATE XII.

Fig. 41. Fore wing pad of *Acinopterus acuminatus* Van Duzee.
" 42. Hind " " *Acinopterus acuminatus* Van Duzee.
" 43. Fore " " *Chlorotettix viridia* Van Duzee.
" 44. Fore " " *Scaphoideus* sp.
" 45. Hind " " *Scaphoideus* sp.
" 46. Fore " " *Eutettix* sp.
" 47. Hind " " *Eutettix* sp.
" 48. Fore " " *Phlepsius* sp.
" 49. Hind " " *Phlepsius* sp.

PLATE XIII.

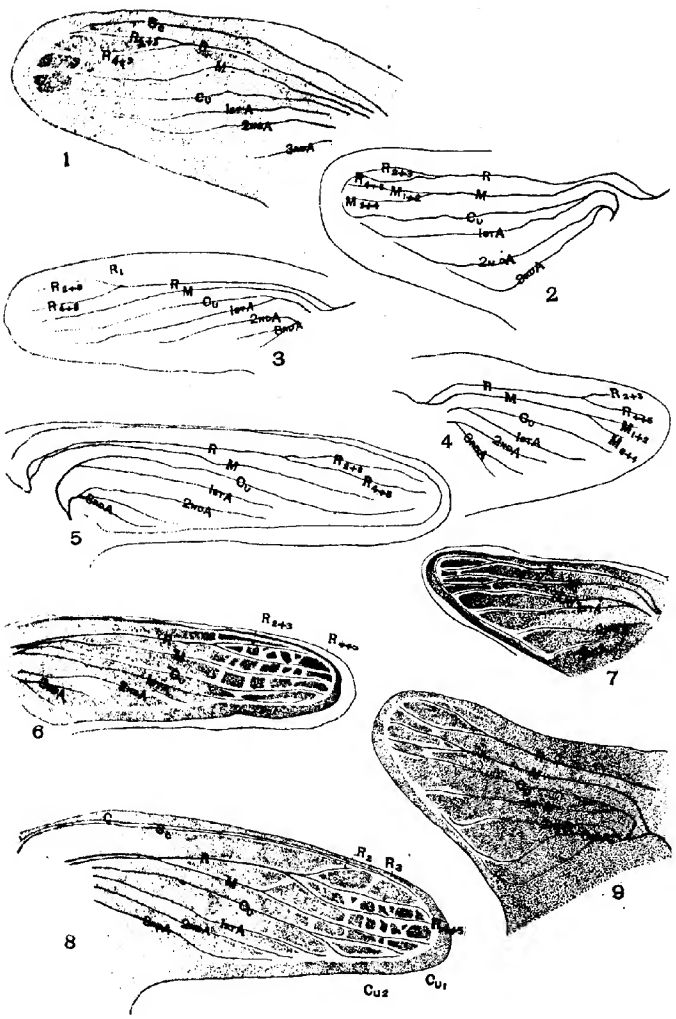
Fig. 50. Fore wing of *Acinopterus acuminatus* Van Duzee.
" 51. Hind " *Acinopterus acuminatus* Van Duzee.
" 52. Fore " *Chlorotettix viridia* Van Duzee.
" 53. Fore " *Scaphhoideus productus* Osb.
" 54. Hind " *Scaphhoideus productus* Osb.
" 55. Fore " *Thamnotettix kennicottii* Uhler.
" 56. Fore " *Eutettix subaenea* Van Duzee.
" 57. Hind " *Eutettix subaenea* Van Duzee.
" 58. Fore " *Phlepsius* sp.
" 59. Hind " *Phlepsius* sp.

PLATE XIV.

Fig. 60. Fore wing pad of *Jassus olitorius* Say.
" 61. Hind " " *Jassus olitorius* Say.
" 62. Fore " " *Cicadula* sp.
" 63. Hind " " *Cicadula* sp.
" 64. Fore " " *Typhlocyba* sp.
" 65. Hind " " *Typhlocyba* sp.
" 66. Fore " " *Empoasca mali* Le B.
" 67. Hind " " *Empoasca mali* Le B.

PLATE XV.

Fig. 68. Fore wing of *Jassus olitorius* Say.
" 69. Hind " *Jassus olitorius* Say.
" 70. Fore " *Cicadula slossoni* Van Duzee.
" 71. Hind " *Cicadula slossoni* Van Duzee.
" 72. Fore " *Dicraneura mollicula* Boheм., redrawn from Melichar.
" 73. Hind " *Dicraneura mollicula* Boheм., redrawn from Melichar.
" 74. Fore " *Eupteryx vanduzei* Gill., redrawn from Gillette.
" 75. Hind " *Eupteryx vanduzei* Gill., redrawn from Gillette.
" 76. Fore " *Dicraneura cruentata* Gill., redrawn from Gillette.
" 77. Fore " *Typhlocyba illinoiensis* Gill.
" 78. Hind " *Typhlocyba illinoiensis* Gill.
" 79. Fore " *Empoasca mali* Le B.
" 80. Hind " *Empoasca mali* Le B.



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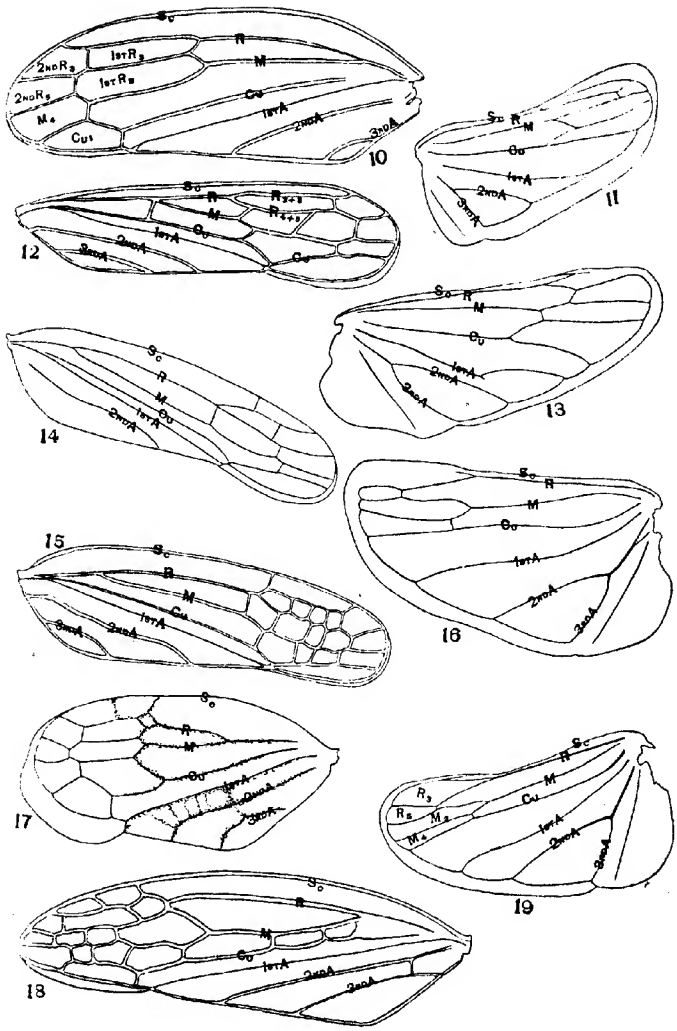

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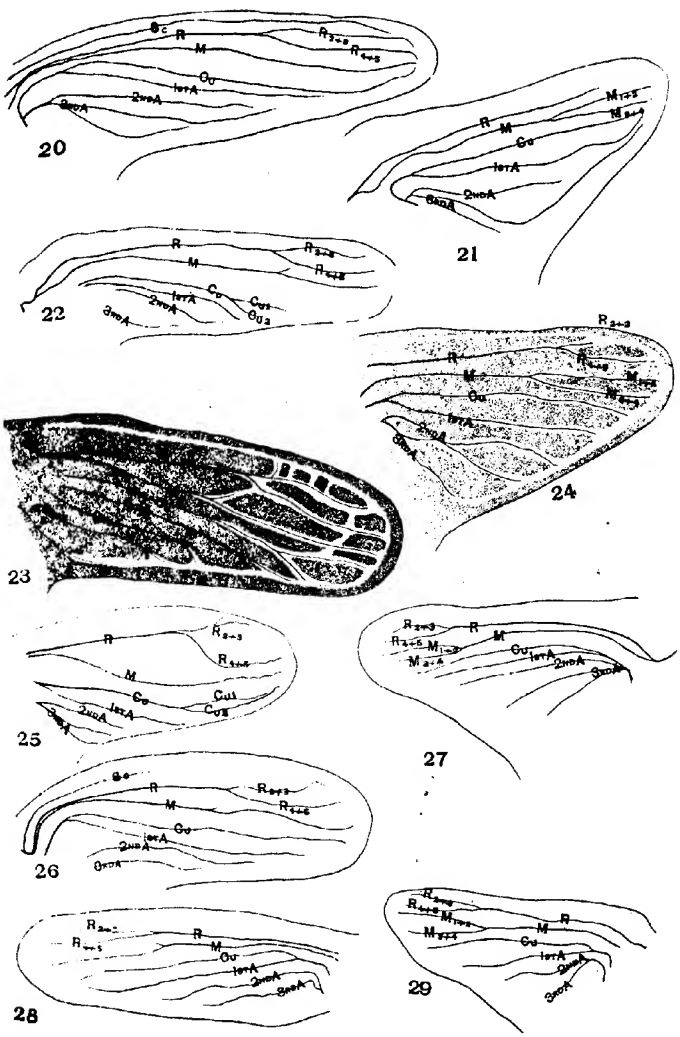

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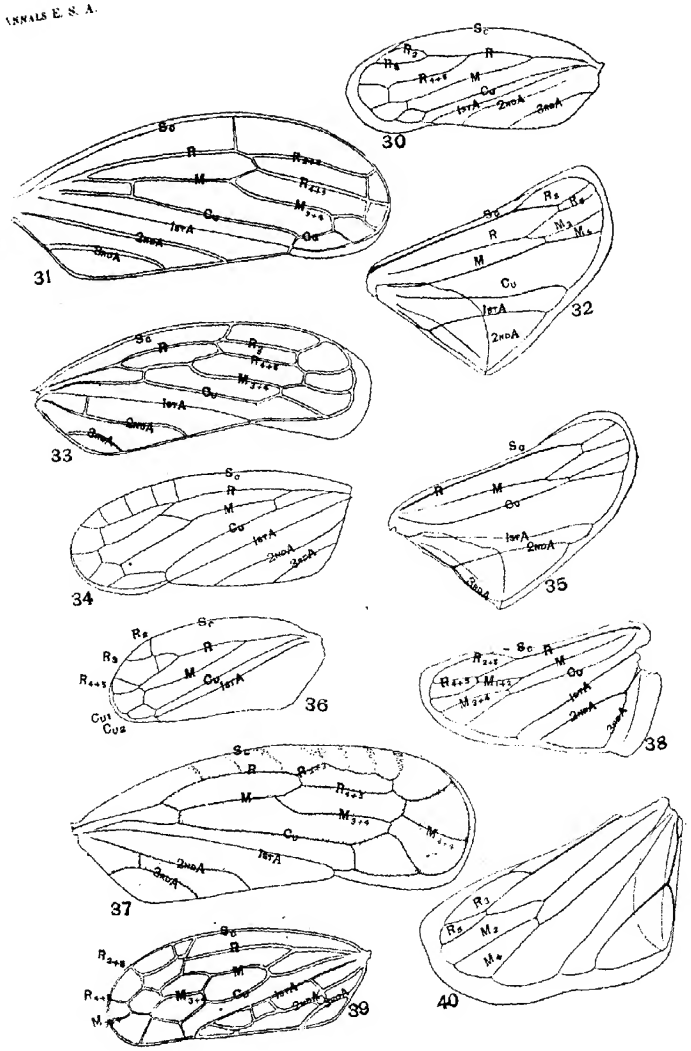

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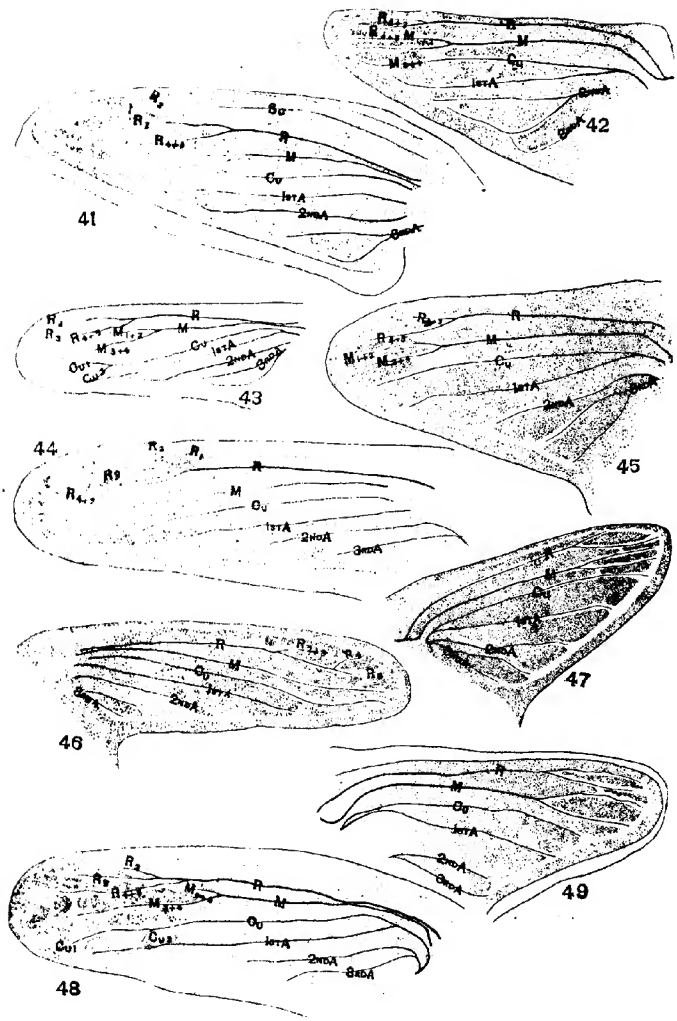

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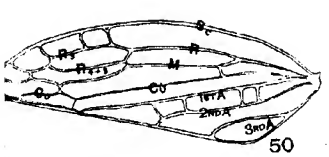

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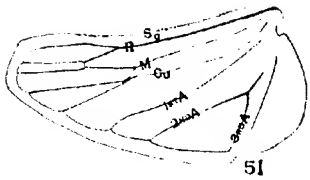

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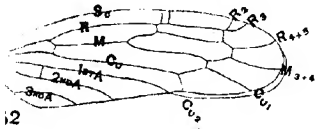

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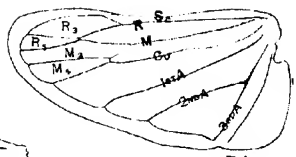

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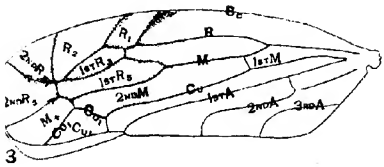

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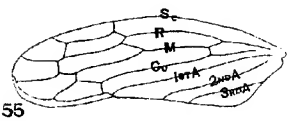

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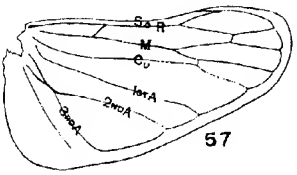

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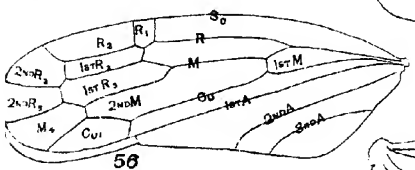

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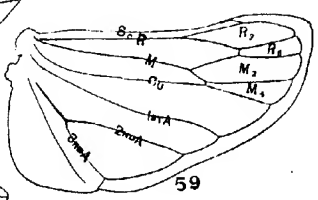

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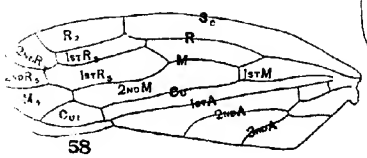

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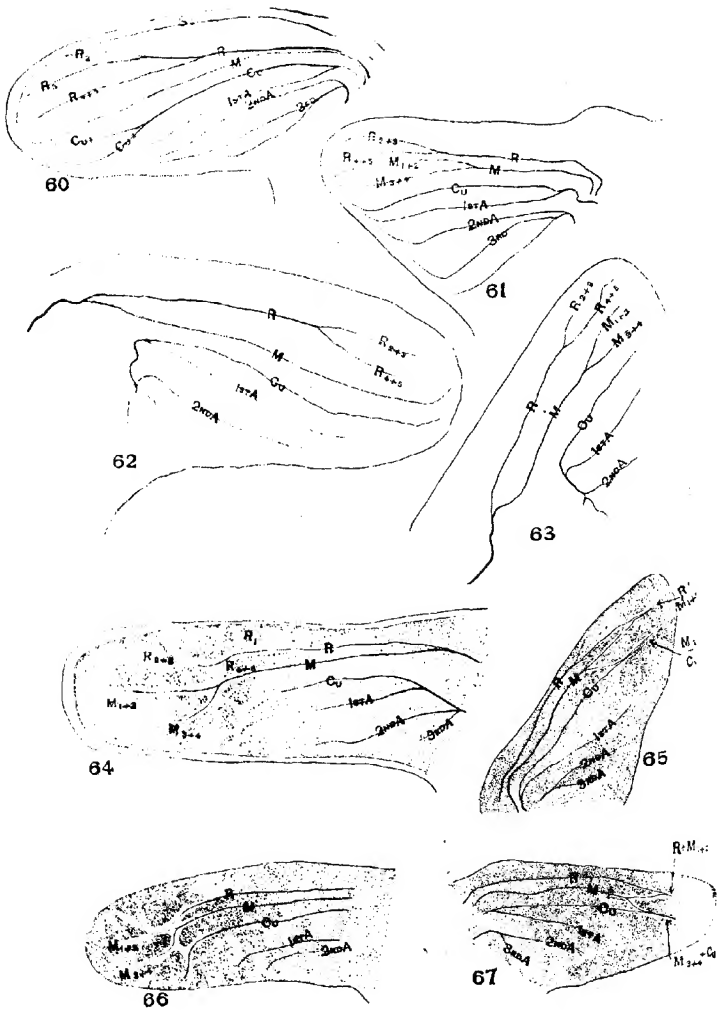

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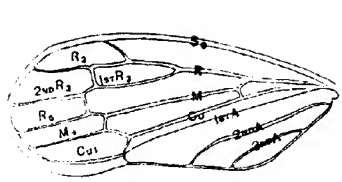

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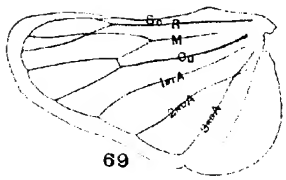

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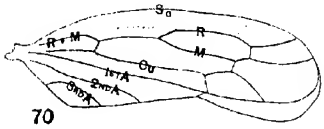

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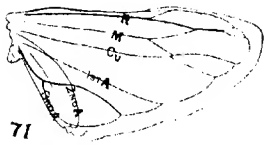

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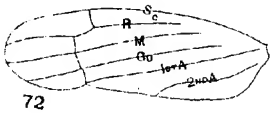

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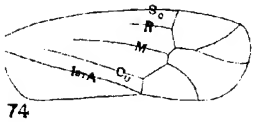

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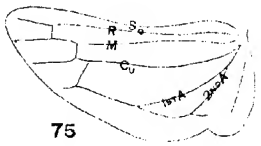

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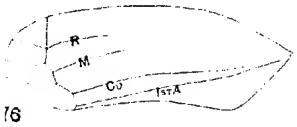

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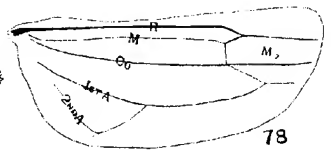

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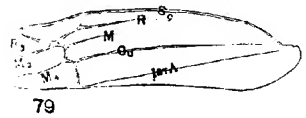

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C. P. Metcalf.

NEW HYMENOPTEROUS PARASITE ON ASPIDIOTUS PERNICIOSUS COMST.*

By DANIEL G. TOWER, Amherst, Mass.

This parasite was reared during October, 1912, from *Aspidiotus perniciosus* Comst. at Amherst, Mass. Specimens were sent to Dr. L. O. Howard, who returned them with the statement that they were a new species of *Prospaltella* and could safely be described as such. Acting on this advice the following descriptions of male and female have been prepared, under the supervision of Dr. H. T. Fernald.

This new species can be inserted in Dr. Howard's key to the species of *Prospaltella* (Ann. Ent. Soc. Am., I, 281, 1908), by adding a fourth alternative to section five as follows: "Wings with a broad dusky band below marginal vein, ... 6," and by adding to section six the alternative, "Wings with a broad dusky band below marginal vein: abdomen nearly black" which would lead to this species.

Prospaltella perniciosi n. sp.

Female: Length, 0.61 mm.; expanse, 1.73 mm.; greatest width of fore-wing, 0.25 mm. General color of living specimens black with the meso-scutellum showing as a prominent light dot. In zylol-balsam mounts the head and central portions of the thorax are light brown. Head: vertex yellowish brown; occiput dark; ocelli dark; eyes black and hairy, the hairs about as long as the diameter of a facet. Antenna: brownish yellow; bulb twice as long as wide, cylindrical and nearly hyaline; scape nearly five times as long as wide, nearly hyaline at each end, more or less cylindrical to spindle shaped; pedicle slightly longer than wide, narrow at its base, widest well toward its tip, its inner side much farther from the axis of the antenna than its outer side; first funicle segment connected with pedicle by a narrow somewhat elongate stalk, which is quite hyaline; this segment a trifle more than half the length of the next and irregular in outline; second and third segments of the funicle nearly equal in size and nearly cylindrical; segments of the club more closely articulated to each other than to the funicle or than are the segments of the funicle to each other; club slightly longer than funicle; first two segments about equal in length, their greatest diameter being at their outer ends; terminal segment elongate, triangular in outline, and longer than either of the other segments, bluntly pointed at tip; all segments of antenna bearing scattered hairs.

* Contribution from the Entomological Laboratory, Massachusetts Agricultural College.

Thorax: Pronotum dark; mesoscutum brownish yellow, darker near the anterior edge, mesoscutar parapsida same color or lighter than mesoscutum with a darker spot well forward toward the base of the fore-wing; scapula dark; mesoscutellum noticeably paler than mesoscutum. Behind the mesoscutellum are two narrow transverse plates dark toward their lateral margins and light near the middle, the posterior plate with a spiracle near each lateral margin. Marginal and submarginal veins of fore-wing nearly equal in length; end of stigmal vein obscurely pointed, not reaching wing margin, its upper side slightly emarginated, its anal margin broadly rounded; a broad dusky band crosses the fore-wing below the marginal vein; hind wing lanceolate. legs pale yellow except the coxæ, femora, and basal halves of the tibiæ, these being dark, the coxa being the darkest portion of each leg, those of the hind legs being the darkest; fore-legs as a whole the lightest and the hind legs the darkest; trochanters nearly hyaline.

Abdomen: Short, broad, nearly quadrangular in outline; quite dark with faint transverse lighter bands and a yellowish brown area near the genitalia; with spines directed backward evident on the sides (above and below also?).

Male: Length, 0.56 mm.; expanse, 1.54 mm.; greatest width of fore-wings, 0.26 mm. Living and mounted specimens appear the same as females, except that they are smaller, and the mesoscutellum is not as light in color. The antenna differs in that the first funicle segment is as long as the second, and its diameter at its distal end is greater than the diameter of either of the other two funicle segments. Its base is rounded and stalked, and it does not give the effect of a bead as does the corresponding segment in the female antenna. The articulation between the second and third segments of the club is not as evident as between the first and second segments, while in the female both articulations are very clear and well defined. The thorax as a whole is darker than that of the female, the only light portions being the mesoscutellum and the portion of the mesoscutar parapsida nearest it. The hind margin of the stigmal vein is more angular than in the female. The faintly cloudy band below the marginal vein is hardly distinguishable. The abdomen is short, much narrower than the thorax, truncate, dark and not showing lighter bands, but lighter near the genitalia which extrude, the tips of these being nearly hyaline.

Described from one female type and forty-three paratypes (on twelve slides) and one male type and four paratypes (five slides). The male type (one slide) and the female type with eleven paratypes (one slide) in the collection of the Massachusetts Agricultural College, Amherst.

One male and nine female paratypes (two slides) deposited in the U. S. National Museum (Type No. 15453).

The remaining paratypes male and female together with some female metatypes, have been retained by the author.

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Organized 1906.

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RESOLUTIONS

On the Death of John B. Smith.

John Bernard Smith, D. Sc. Professor of Entomology Rutgers College, Entomologist N. J. Agricultural Experiment Station, Fellow and former President of the Entomological Society of America, died at his home in New Brunswick, New Jersey, on March 12, 1912.

As an ardent collector, systematist, and morphologist; Editor of Entomologica Americana; Assistant Curator of Insects in the National Museum; Professor of Entomology and Entomologist of the Agricultural Experiment Station of New Jersey, Dr. Smith's contributions to American Entomology have been of such extended and valuable character that his name has been and will remain a familiar one to workers in Entomology.

He was a genial friend and companion and remembrance of his personal traits will be treasured as among the lasting possessions of memory among his associates.

As a devoted member and officer in this society he labored faithfully in promoting its welfare and we now resolve that this tribute to his character be printed in the Annals of the Society as the public expression of our admiration for the man and our sense of loss in his death.

Committee HERBERT OSBORN,
HENRY SKINNER,
E. P. FELT.

JOHN B. SMITH.

THOMAS H. MONTGOMERY.

RESOLUTIONS

On the Death of Thomas H. Montgomery.

In the death of Professor Thomas H. Montgomery, Jr., on March 19, 1912, the Entomological Society of America lost a member whose entomological work was concerned mainly with the Hemiptera and the Araneina, dealing with various phases of the morphology, embryology and ecology of these groups in themselves, and as furnishing material for studies on the deeper problems of inheritance and sex-determination. He did not confine himself to these groups of animals but extended his researches to other non-entomological fields of zoology and in all he made valuable contributions to knowledge and to theory.

In appreciation of his accomplishments and in sorrow at his early death, we enter this record on our minutes and extend to Mrs. Montgomery our deep sympathy in her and our loss.

Committee Philip P. Calvert,
Henry Skinner,
J. H. Comstock.

PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF AMERICA.

Cleveland Meeting.

The seventh annual meeting of the Entomological Society of America was called to order by President Stephen A. Forbes at 10:00 A. M., Tuesday, December 31st, in the Auditorium of the Normal School. All the meetings of the Society were well attended, seventy-five or more at each session, and it was pronounced by several the best meeting of the Society that they had attended. The following committees appointed previous to the meeting, were named:

Committee to draft resolutions on the death of Dr. John Bernhardt Smith—Herbert Osborn, Henry Skinner, E. P. Felt.

Committee to draft resolutions on the death of Dr. Thomas Harrison Montgomery, Jr.—Philip P. Calvert, Henry Skinner, J. H. Comstock.

The chair was directed by motion to appoint the following committees: Committee on Resolutions; Committee on Nominations; Auditing Committee.

The following papers were then read:

C. Betten, Lake Forest University; An Interesting Feature in the Venation of Helicopsyche, the Molannidæ, and the Leptoceridæ. (Printed in this number of Annals).

Discussion: W. A. Riley—Dr. Betten's interpretation of the modifications of R_5 is especially interesting as still further emphasizing the close relationship in wing venation between the Trichoptera and the Lepidoptera. The lepidopterous wing venation exhibits specialization by reduction and Dr. Betten has clearly demonstrated that what has been regarded as an accessory vein is really a branch of a primary vein.

Lucy W. Smith, Mt. Holyoke College: Mating and Egg-laying Habits of Perla immarginata. (To appear in June number of Annals.)

Alvah Peterson, University of Illinois: Head and Mouth parts of Cephalothrips yuccæ.

A preliminary report on the asymmetry of the mouth-parts of Thysanoptera. A detailed description of the anatomy of the mouth-parts and head capsule of *Cephalothrips yuccæ*, a species belonging to the suborder Tubulifera, was given. Numerous details and parts heretofore undescribed as to mandibles, hypopharynx, epipharynx, arms of tentorium, etc., were shown. Similar observations were made on *Anthothrips verbasci* in order to verify results found in *Cephalothrips yuccæ*.

Comparing the work done by H. Garman on *Limothrips cerealium*, a species of Terebrantia, with the work done by Muir and Kershaw, on a species of Tubulifera, a difference in interpretation exists as to whether the asymmetrical parts are mandibles or maxillæ. Muir and Kershaw interpret the asymmetrical parts as maxillæ. Observations made by the writer on two species of Tubulifera verify their position in general. The writer expects to continue his observations on species of the suborder Terebrantia to determine if possible whether the interpretation of H. Garman is correct or not.

Discussion: R. A. Cooley—It was asked as to whether any evidence of glandular secretion from the mouth was found, which being answered in the negative, it was stated that in a species feeding on terminals of currant and gooseberry we have noticed a considerable distortion of the leaves and stem, suggeting the possibility of a secretion introduced while feeding.

J. E. Wodsedalek, University of Wisconsin: Life History and Habits of Trogoderma tarsale, a Museum Pest. Read by Title.

Leonard Haseman, University of Missouri: Life Cycle and Development of the Tarnished Plant Bug, Lygus pratensis Lin. Presented by the Secretary.

Owing to the very serious injury to peach and pear in the early spring which seemed to be due to the work of the tarnished plant-bug, the writer has undertaken a careful study of the life cycle, habits and development of this insect. The work has been carried through the late summer and fall months and will be continued throughout the following spring and summer.

In this work it has been found that the tarnished plant-bug breeds largely upon various flowering weeds such as wild asters, daisies, and mare's tail (*Erigeron canadensis*). The tarnished plant-bug deposits its eggs in the blossoms of the host plant and not in the tissue of the leaves or stems. These eggs hatch in from five to seven days and the insect passes through five distinct nymphal stages in its development in the place of four, as other writers have maintained. The insect remains in each nymphal stage for about the same length of time and completes its growth in from thirty to thirty-five days.

Discussion: P. J. Parrott—There occurs in New York a species (*Lygus invitus*) Say which is during some seasons quite destructive to pears. In feeding on the fruit, the epidermis is ruptured by the proboscis and protruding granular areas form about the wounds. This species closely resembles *pratensis* and is easily confused with it. In order to establish distinguishing characters we have bred the two insects through their various five stages. Both species have five nymphal instars and can

easily be separated by certain characters which we hope to explain later. I noted with much interest the remarks on oviposition habits of *pratensis*, and I would also add that we have obtained the eggs of this species from ripe strawberries, raspberries and blackberries, and for rearing the insect during its various nymphal stages we have found nothing more satisfactory than the berries of these different fruits.

Victor E. Shelford, University of Chicago: The Ontogeny of Elytral Pigmentation in Cicindela.

The pigment develops in the form of a faint pattern, somewhat variable but with certain lighter areas occurring in the same general position in several species. These lighter areas lie between the tracheæ and in certain transverse bands: their positions correspond to those of certain white markings of Ethiopian and Oriental species.

Discussion: Miss Annette Braun—The question was raised as to whether the position of the dark transverse bands on the elytra of *Cicindela* is determined by structural characters of the elytra, citing work on the ontogeny of wing pattern in certain moths where the position of the tip of the veins decides the position of markings, the tip of the vein remaining unpigmented.

V. E. Shelford. The dark cross bands which separate the spots are not correlated with any known elytral structures. There is no evidence of metamerism in the wing. The pigment develops throughout the elytron, the base does not appear oldest.

N. L. Partridge, University of Illinois: The Tracheation of the Pupal Wings of some Saturnians.

A method of preparing permanent mounts of lepidopterous pupal wings was described. The pupal wings were removed in the customary manner and the specimens secured, floated upon clean water to straighten the wings and remove any dirt which might adhere to them. Then they were placed on a clean, untreated, glass slide, smoothed, and allowed to dry, without further treatment. The result was a transparent mount showing all the tracheoles as well as the tracheæ. Some of these mounts were used as lantern slides giving clear images on the screen.

It was shown that a greater amount of variation was found in the pupal wings than in the adult wings. The homologies between the tracheæ and veins of the specimens shown was indicated.

L. B. Walton, Kenyon College: Studies on the Mouth-parts of Rhyparobia maderiæ (Blattidæ) with a consideration of the Homologies existing between the Appendages of the Hexapoda.

The question as to the homologies existing among the paired appendages of the Hexapoda has received attention from various investigators.

and in particular from Hansen, Heymons, Borner, Verhoeff, and Escherich, none of whom however have progressed far toward a satisfactory solution of the problem. In general it has been accepted that the stipes and mentum correspond to the thoracic and abdominal coxæ while the maxillary and labial palpi were equivalent to the trochanter, femur, etc., or the functional leg.

Studies on *Rhyparobia maderiæ* the "giant cockroach" from Panama, particularly of 10 mm. and 12 mm. embryos, as well as other investigations in connection with the appendages of the Thysanura, make it evident that the typical appendage (mouth-parts, thoracic, abdominal, caudal) of the Hexapoda consists of seven definite areas best represented by the maxillæ with the galea, lacina, ectostipe,[1] endostipe, ectocardo, endocardo, and palpus. Futhermore the palpus should be homologized with the stylus of the thoracic and abdominal coxæ and not with the functional leg, inasmuch as both palpus and stylus are appendages of homodynamous areas (ectostipe, ectomentum, meron) while the leg is an appendage of the area (endocoxa) corresponding to the endostipes.

The facts noted suggest the origin of the biramose appendage of the Hexapoda directly from the parapodium of the Polychaeta, the notopodium and neuropodium arising in connection with the dorsal and ventral bundles of setæ and corresponding to the outer (ectal) and inner (endal) groups of sclerites as outlined above. It would thus appear that the Arthropoda are a polyphyletic group, and that the relationship between the appendages of the Hexapoda and Crustacea is a more remote one than generally accepted in connection with the studies of Hansen and Borner.

The historical development of the problem as well as the presentation of the facts which would seem to establish the views here advanced, will appear in the completed paper of which this is a partial summary.

Discussion: W. A. Riley—I have been especially interested to learn that Dr. Walton is swinging away from his earlier belief in the double nature of the insect segment. It has seemed to me that embryological data afforded no evidence in support of the theory though there are indications of the biramous nature of the appendages. The theory of the origin of the insect appendages from the pleuropodes receives much additional support from the work here presented.

The President announced the following committees:

Committee on Resolutions—S. J. Hunter, W. A. Riley, and L. B. Walton.

Committee on Nominations—Herbert Osborn, R. A. Cooley, and Cornelius Betten.

Auditing Committee—P. J. Parrot, A. F. Burgess, and W. E. Britton.

1. The prefixes "ecto" and "endo" have been utilized in an attempt to establish a better nomenclature while minor changes have been made in the terminology of older parts, e. g. "ectostipes" is a more cumbersome term than "ectostipe."

The Society then adjourned to meet at 2:00 p. m. when the following business was transacted and papers read:

The Committee appointed to draft resolutions on the death of Dr. John Behrnhardt Smith presented their report. It was ordered accepted and printed.

James Zetek, Sanitary Commission Canal Zone: Determining the Flight of Mosquitoes. Read by Title.

William A. Riley, Cornell University: Some Sources of Laboratory Material for Work on the Relation of Insects to Disease.

The demand for at least elementary courses on the relation of insects to disease brings up the question as to available laboratory material. There is comparatively little difficulty in obtaining the parasitic mites, ticks, lice, house-flies, mosquitoes and fleas in their various stages, but it is usually assumed that most of the pathogenic Protozoa are tropical species and that nothing can be substituted for them in laboratory work. As a matter of fact, a number of insect-borne Protozoa and worms occur in this country and together with other blood parasites whose life-history is less better known, are available for laboratory work. The species discussed were *Trypanosoma lewisi* a widely distributed parasite of brown rats; *Trypanosoma rotatorium* from the frog; the related *Corithidia* from the "sheep tick"; *Herpetomonas* from the house-fly; *Monocystis* from the seminal vesicles of the earth worm as introductory to the study of the Hæmosporidia; *Lankesterella ranarum Haemogregarina sp.; Proteosoma, Halteridium, Babesia hilaria* in the blood of the crow and English sparrow, and *Dipylidium caninum*, the double-spored tape worm of dogs, cats, and man.

Discussion: F. L. Washburn—It was asked whether Dr. Riley had ever found acridids killed by the presence of an excessive number of gregarines. Being answered in the negative, it was stated that a party in western Oregon had recently written him of the occurrence of large swarms of locusts in the Willamette valley which did not lay eggs, but perished in large numbers and a microscopical examination disclosed a very large number of gregarines in each insect and the reproductive glands entirely disintegrated.

Y. H. Tsou and S. B. Fracker, University of Illinois: The Homology of the Body Setæ of Lepidopterous Larvæ.

This paper consisted (1) of a statement of the difficulties involved in homologizing the body setæ of these larvæ, (2) of a consideration of the serial homology of the setæ of the different segments and (3) of the specific homology in the larger groups. Greek letters were employed to designate the setæ in order to obviate the confusion which has arisen from the use of numbers in different ways by different authors. The

prothorax of *Hepialus* was shown to represent the primitive arrangement of setæ and was used as a type for determining the homology of the setæ on the different segments. The authors had studied many species and gave figures of four: *Hepialus lectus and H. humuli* of the Jugatæ, *Pseudanaphora arcanella* of the Tineidæ and *Mamestra picta* of the Noctuidæ. Each of these was compared with the type, segment for segment. This is the first time the setæ of the prothorax have been homologized with those of the other segments.

Discussion: W. A. Riley—I wish to speak in appreciation of the important work which Mr. Tsou and Mr. Fracker have reported upon—work which is especially difficult to present in a non-technical manner. It is quite customary to ridicule work upon such a subject as the "hair of a caterpillar" and even some entomologists are inclined to question the possibility of homologizing such structures. Yet, as Professor Comstock sometimes says, "We read that the very hairs of our head are numbered, and in the case of lepidopterous larvæ this may be literally true". That certain hairs or groups of hairs may be persistent and may be homologized throughout a wide series of forms, is due to the fact that they possess important sensory functions. Pioneer work in this country on the homologizing of setæ was done by Dyer, and the late C. B. Simpson extended this by an important study which is deposited as a thesis in the Cornell University library. It is gratifying to see the work continued under Dr. MacGillivray who is best qualified to supervise it.

Anna H. Morgan, Mt. Holyoke College: Eggs and Egg-laying of May-flies.

This study of May-fly eggs was made to determine the relative fecundity of different species. This led to the study of a series of elaborate sculpturings found upon the chorion. In several species the chorion bears long thread like extensions which terminate in viscid spheres or disks. These seem to help buoy up the eggs. Threads two and three inches long were found. In nature these threads are probably entangled in sticks and vegetation and this prevents the eggs from being covered by silt. In the ovaries of half grown nymphs these structures are well defined and are of aid in connecting up the life histories where rearing is impossible.

Discussion: Philip P. Calvert—It was remarked that Miss Morgan's statements that *Heptagenia interpunctella* and *H. pulchella* closely resembled each other as adults and lived in the same situation as larvæ and eggs might seem to indicate an exception to Jordan's law that the nearest related species are

always separated from each other by some kind of a barrier, but in view of the great differences in the eggs of the two species, it might be doubtful whether these two species are really so closely related. It is therefore evidently necessary to know all the stages of two species before one can pronounce on their relationships and whether they do or do not contradict the law mentioned.

Herbert Osborn, Ohio State University: Notes on Cicadidæ with Especial Reference to the Ohio Species.

Cicadas constitute a conspicuous element in an Insect fauna and their relation to varied forest conditions was discussed especially for the species occurring in Ohio. The origin and function of the tympanal organs present problems for study and the suggestion is made that this structure is primarily a secondary sexual character functioning in sexual excitation and only incidentally a sound producing organ.

Frank E. Lutz, American Museum Natural History: On the Biology of Drosophila ampelophila.

This insect is remarkably useful in laboratory work since it can be kept going throughout the year on bananas as food and its short life-cycle (about ten days to two weeks) enables one to get a large number of generations. Sexual difference characterizes the insect. Not only do the sexes differ in adult color and structure but they differ in the duration of the immature stages, in their reactions to light and the age at death.

E. P. Felt, State Entomologist, New York: Observations on the Biology of a Blow Fly and a Flesh Fly.

A study of *Phormia regina* Meign. and *Sarcophaga georgina* Wied. was undertaken primarily for the purpose of obtaining data which could be used as a basis for estimating the period a human body had lain exposed to the elements in midsummer. Our knowledge of these two species is summarized and original data are given of the habits and duration of the various stages under known climatic conditions. The egg of *Phormia* and the three larval stages and puparium of both species are described and a bibliography of each appended.

The Society adjourned at 4:30 p. m., to meet Wednesday, January 1st, at 10:00 a. m.

The annual business meeting of the Society was held upon reconvening and the following reports presented:

The Secretary presented the following report for the Executive Committee, which met at the Hotel Euclid, Tuesday evening, December 31.

REPORT OF THE EXECUTIVE COMMITTEE.

Your Secretary asks the privilege of departing from the custom of former secretaries in reporting the various matters that have been submitted to the Executive Committee in the interim between meetings. The secretary feels that all these matters should be reported at the annual meeting of the Executive Committee and put on record in the proceedings of the Society.

The following matters were considered during the year 1912:

1. The revision of By-Law No. 9 as reported in the Annals, Vol. V, p. 83.

2. The appointment of Professor Herbert Osborn, the retiring President, as the second councilor of the Society to the American Association for the Advancement of Science.

3. The following were named as delegates to the second International Congress of Entomologists, held at Oxford, England, August 5-10, 1912:

Professor J. H. Comstock, Dr. Henry Skinner, Dr. W. J. Holland, Professor V. L. Kellogg, Dr. Philip P. Calvert, Dr. L. O. Howard, Dr. W. M. Wheeler, Professor Herbert Osborn, Professor S. A. Forbes, and Professor J. G. Needham.

4. The apointment of a committee of three to draft resolutions inviting the International Congress of Entomology to hold its next meeting, 1915, in America. The following were named: Professor S. A. Forbes, Chairman; Dr. Henry Skinner, and Professor J. H. Comstock. The success attending the efforts of this committee are reported in another place.

5. That there be printed at the head of the list of papers on the program for each annual meeting the following statement: Each paper will be limited to fifteen minutes, second titles will be placed at the end of the program and read in the order listed.

Upon an invitation from the Academy of Natural Sciences of Philadelphia, the President named the following as delegates to the celebration of the centenary anniversary of the academy: Professor John B. Smith, Dr. L. O. Howard, Dr. E. P. Felt, Dr. W. E. Britton, and Dr. W. M. Wheeler.

The following twenty-seven new members were elected by the Executive Committee, June 1, 1912:

J. Lyonel King.	H. R. Niswonger.	James McDunnough.
H. M. Parshly.	C. L. Metcalf.	Miss E. D. Faville.
M. M. High.	Prof. O. W. Oestlund.	N. L. Partridge.
E. H. Strickland.	P. W. Mason.	Col. T. L. Casey.
A. C. Burrill.	J. C. Faure.	S. C. Bishop.
J. H. Paine.	Harold Morrison.	D. L. Crawford.
D. C. Mote.	E. M. Schalck.	E. C. Cotton.
Prof. T. D. Jarvis.	R. A. Grizzell.	A. W. Baker.
Lawson Caesar.	Prof. R. W. Hegner.	A. B. Johnson.

The following have died during the year:

Dr. John B. Smith.	Prof. G. W. Taylor.
Prof. T. H. Montgomery, Jr.	E. L. Jenne.

The following resignations were presented, accepted by the Executive Committee, and the membership terminated:

Prof. C. E. Johnson.	E. J. Kraus.	H. G. Smith.
E. D. Keith.	Prof. F. H. Shoemaker.	E. S. Tucker.
G. Chagnon.		

A list of twenty names of persons who had been dropped for the non-payment of dues for two years or within one year of election to membership, was presented and adopted. This is in accordance with Sections 7 and 8 of the By-Laws.

The following twenty-four names were proposed for membership and elected by the Executive Committee at its meeting last evening:

C. J. Drake.	C. Carter.	H. Fox.
W. J. Phillips.	W. E. Snyder.	D. Milton Brumfiel.
A. G. Vestal.	C. E. Hood.	J. J. Culver.
M. M. Wells.	Margaret Washington.	C. H. Baldwin.
C. W. Creel.	F. W. L. Sladen.	P. S. Welch.
C. W. Long.	W. A Ross.	E. M. R. Lamkey.
R. W. Leiby.	E. H. Gibson.	R. H. Wilson.
O. C. Bartlett.	C. R. Neillie.	W. J. Kostir.

The membership of the society as given in the last volume of the Annals contains two honorary fellows, 33 fellows, and 356 members, or a total of 391. There is reported above the death of one fellow and three members, the resignation of seven members, and the dropping of 20 others, which reduces the roll to 359. To this number should be added the 27 members elected in June and the 24 elected at this meeting, which makes the present total membership of the society 410.

TREASURER'S REPORT.

Cash on deposit in the First National Bank of Champaign, Illinois, December 19, 1911		$ 696.60
Life Membership Fees deposited in Rothschild Bros. Savings Bank of Ithaca, New York, with interest at 4% to May 3, 1912		107.85
Cash received from Herbert Osborn, Managing Editor of the Annals		428.35
Cash collected as dues		812.56
		$2,045.36
Bills Paid	$1,904.49	
Life Membership Fees deposited in the Citizens Savings and Trust Co., of Cleveland, Ohio	100.00	
Cash on deposit in the First National Bank of Champaign, Illinois, December 9, 1912	40.87	
		$2,045.36

If the cash balance for 1912 is compared with that of 1911, it might seem that the financial condition of the society was not very good. The financial conditions on the contrary are the best for any year of which your treasurer has made any study of the accounts. He has paid for six numbers of the Annals in addition to handling the expense of mailing certificates of membership. Certificates have been sent to all persons included on the membership roll of the society and if there are any who have not received a certificate, the secretary should be notified. The net expense of issuing the six above mentioned numbers of the Annals alone was $1731.93. The only outstanding account is for the December Annals, which had not been issued when the Treasurer's account were closed.

The Executive Committee apointed the Secretary-Treasurer and Professor J. H. Comstock at the Washington meeting a committee to deposit the fees of life members in a bank that they should consider safe at a good rate of interest. After considerable correspondence the Citizens Savings and Trust Company of Cleveland, Ohio, was selected and the funds deposited there May 3, 1912, where they will draw four per cent interest.

The following amendment to the Constitution submitted at the Boston meeting and voted upon at the Washington meeting was referred back to the Executive Committee by the latter meeting for further consideration:

Article IV. Section 3. The President shall represent the Society upon the Council of the American Association for the Advancement of Science until such time as the Society shall be qualified for representation by two councillors, in which case the second councillor shall be elected from the fellows by the Executive Committee.

To be amended to read:

Section 3. Councillors to the American Association. The President and the preceding Past-President shall represent the Society upon the Council of the American Association for the Advancement of Science.

The Executive Committee would recommend the following amendment:

Section 5. Councillors to the American Association: The President and the preceding Past-President shall represent the Society upon the council of the American Association of the Advancement of Science. In case of the death or resignation of either or both councillors, the vacancy shall be filled by the Executive Committee.

The Executive Committee took the following action: It was moved that the President and the preceding Past-President should represent the Society upon the Council of the American Association for the Advancement of Science during the year 1913.

Mr. Edward P. VanDuzee, Librarian of the Grosvenor Public Library, Buffalo, New York, who has made a special study of the Hemiptera, was by a unanimous vote of the Executive Committee elected a fellow of the society.

The following amendments and additions to the constitution are recommended:

Article V. Section 3. Election of Officers—All officers shall be elected by ballot at the annual meeting for the term of one year and shall be eligible for re-election. Their term of office shall commence with the first of June following their election.

To be amended to read as follows:

Article V. Section 3. Election of Officers—All officers shall be elected by ballot at the annual meeting for the term of one year and shall be eligible for re-election.

The following additional article to the Constitution, dealing with the publication and management of the Annals, to be number VII and the present article of that number, to be numbered VIII:

ARTICLE VII.

SECTION 1. Publication—The official publication of the Society shall be known as the Annals of the Entomological Society of America. Each volume shall consist of four quarterly fascicles and the first fascicle of each volume shall contain the proceedings of the annual meeting.

SEC. 2. Editorial Board—The publication shall be under the charge of an Editorial Board consisting of ten members, one of whom shall be Managing Editor. The Managing Editor and his associates shall be responsible for the selection of the material to be published.

SEC. 3. Election of Editorial Board—The members of the Editorial Board shall be elected by the Executive Committee. Each member of this board, except the Managing Editor, shall serve for three years or until his successor has been elected, three members retiring annually.

SEC. 4. Report Managing Editor—The Managing Editor shall present a report at each annual meeting to the Executive Committee and the accounts of his office shall be reported upon by the Auditing Committee.

The Executive Committee took the following action regarding the mailing of the Annals, this action is to be printed on page three of the cover of each number of the magazine:

The Managing Editor is provided with the most recent address of all members on record in the Secretary's office for mailing the numbers of the Annals and hereafter members complaining of the non-receipt of numbers must present their complaint to the Secretary within four months from the date of the mailing of the issue. After that time the numbers will be furnished only at the regular published rate.

The Secretary reported the receipt from Jas. A. Barr, Manager of Conventions for the Panama-Pacific Universal Exposition of an embossed invitation issued by the president and directors of the Exposition, inviting the society to hold its meeting for 1915 on the Pacific coast. This meeting is to be held either in the Auditorium provided by the Exposition and located about half a mile from the Exposition entrance or at the University of California or at Stanford University. The Executive Committee offers the following recommendation: That the Executive Committee recommend to the Society that a special committee of five be appointed, to include two Pacific coast members, to consider and report at the next annual meeting concerning the desira*bility of holding a meeting in San Francisco in the summer of 1915.*

On motion, the report of the Executive Committee was adopted.

The President named the following committee to consider the desirability of holding a meeting in San Francisco in 1915: E. P. Felt, New York State Entomologist, Albany, N. Y., Chairman; Vernon L. Kellogg, Stanford University, California; A. J. Cook, Horticultural Commission, Sacramento, California; W. M. Wheeler, Harvard University, Cambridge, Mass.; T. D. A. Cockerell, University of Colorado, Boulder, Colorado.

The committee appointed to draft resolutions on the death of Dr. Thomas Harison Montgomery, Jr., presented their report. It was ordered accepted and printed.

The following reports were presented:

REPORT OF THE MANAGING EDITOR OF THE ANNALS.

The report upon the progress of the Annals for the year 1912 might follow very closely the statement for the year previous but I feel that we are warranted in counting the past year as one of even more solid growth and that we may look with still greater confidence to future improvement.

In the matter of financial support there has been a distinct gain and the receipts of the editor which show a total of $551.53 of which $193.40 were for subscriptions, $176.55 for back volumes sold and $181.58 for reprints, etc., from authors indicates what may be expected as practically permanent revenue though we may not be equally successful every year in sale of back volumes.

The editor's expenses have been $63.05 for engravings, $35.20 for labor and stenographic service, $24.93 for express and postage, and $428.35 has been turned over to the treasurer.

In this connection it may be mentioned that a little effort by members in helping to place sets of the back volumes in libraries not yet supplied will assist materially in increasing income and giving support to enlargement and improvement. I am sure that such effort was helpful in the past year.

While we have not published quite as many pages of matter as for 1911 the volume will reach over 450 pages and includes a very creditable series of papers. The editor has in hand matter enough to practically fill a good March number and other desirable papers in sight. This with the prospect of a somewhat larger fund to devote to printing the coming year assures us I believe an excellent volume for 1913.

The Managing Editor desires to take this opportunity to express his gratitude for the many important aids rendered by the members of the Editorial Board in securing desirable contributions. He is especially indebted to Professors Folsom and MacGillivray for assistance in the issuing of the September number.

He appreciates particularly the cordial and hearty cooperation which has marked the relation of the members of the society to this enterprise.

Respectfully submitted,

HERBERT OSBORN,
Managing Editor.

REPORT OF THE AUDITING COMMITTEE.

We, the undersigned, have this day examined the accounts of Alexander D. MacGillivray, Treasurer and Secretary of the Entomological Society of America for the year ending December 10, 1912, compared the vouchers therewith and found the same correct and properly cast.

Signed P. J. PARROTT,
A. F. BURGESS,
W. E. BRITTON.

REPORT OF THE COMMITTEE ON NOMENCLATURE.

Your Committee on Nomenclature has to report that no questions have been submitted to it for consideration during the past year.

The discussion of the idea of *nomina conservanda* has been much in evidence of late, and the members of the committee have very decided personal opinions upon that subject. They realize, however, that any expression of their opinion as a committee would have no more weight than the sum total of their individual views, and therefore do not present any recommendation on the subject. Attention should be called to the point, however, that in the numerous lists of workers published, who have expressed themselves on the subject, many are morphologists only secondarily interested in questions of nomenclature, and rarely doing anything themselves in this subject. It would seem that the opinions of this class should hardly be given equal weight with those offered by persons constantly engaged in systematic work and who are therefore much more familiar with the difficulties constantly presenting themselves under either method.

It may also be appropriate here to call attention to earlier proposals nearly forty years ago, for the establishment of *nomina conservanda* which were favorably received at first, and to some extent adopted for a few years, but generally abandoned after a time. (Rules of Nomenclature as authorized to be published by the Entomological Club, A. A. A. S., July, 1877).

Your committee is inclined to regard the International Code as the one to accept in all cases, representing as it appears to, the formulated opinions of the largest body of scientific zoological workers in the world, and therefore presenting the largest number of supporters, to serve as a nucleus around which scientific opinion at large should concentrate and crystallize. They regret, however, that recent interpretations of the code seem to imply that a generic name accompanied by more or less of a description, but without reference either by name, figure, description or otherwise to any described and named species of animal, should be held as valid. They do not feel that this is any real use of a binomial nomenclature, and would welcome a ruling that any generic name to be applicable to any animal must be published in connection with some described or otherwise clearly indicated species, and that all generic names not so published should be regarded as *nomina nuda*.

Signed,

H. T. FERNALD,
E. P. FELT,
T. D. A. COCKERELL.

The report of the Committee on Nomenclature was accepted and ordered printed.

The following motion presented by Philip P. Calvert and seconded by F. L. Washburn was presented:

Moved that it is the sense of this meeting of the Entomological Society of America that the use of the International Code

of Nomenclature be recommended for the use of Entomologists generally. Carried.

The following report, of the delegates to the International Congress, in attendance at the Cleveland meeting, was presented:

REPORT OF DELEGATES TO THE INTERNATIONAL CONGRESS OF ENTOMOLOGY, AT OXFORD, ENGLAND.

While no official report has been called for from the delegates of the Society, and while from the fact that the delegate representation was not provided for at the Congress, such report may be unnecessary, it seems that some statement as to the work accomplished and scope of the Congress may be in order.

The delegates can all report a very enjoyable occasion with delightful opportunities for acquaintance with Entomologists from various countries who were at the Second International Congress. They can also report with much appreciation the advantages of the place of meeting, and the enthusiasm with which the Congress was entertained by the local Entomologists.

In the various sectional meetings there were presented a large number of creditable papers and these provoked profitable discussions. The sections in Taxonomy and Economic Entomology were particularly well attended and successful. The questions upon nomenclature introduced by the resolution from the Entomological Society of London, were the subject of much discussion, and resulted in the provision for an international committee to consider the particulars of nomenclature. The details for this arrangement will doubtless in time come to the Society with a request for the designation of a member of the Society to serve on such committee.

The constitution of the Congress appears to your delegates to be faulty in that it does not provide delegate representation from the different countries or from National Societies, and until such provision is made it appears to us that the results of action in the Congress must fail to secure any general acceptance.

The Congress, as at present constituted, is composed simply of members who may pay the fee, and such membership is open to all persons whether entomologists or not, so it follows that any individual subscribing the membership fee has just as much weight in voting as a delegate or representative from a country, representing hundreds of society members. Further, the constitution of the Executive Committee, which seems not to be subject to election by the Congress at large, as well as the election of officers and decision as to place of meeting, are entirely in the hands of the Executive Committee of four members.

While the arrangement for the committee on nomenclature may prove successful, there are certainly many other questions of international importance, which should be considered by such a Congress, and we believe that it should be urged upon the Executive Committee

that some provision be made for delegate representation from different countries, and from different Entomological Societies, and that a definite constitution be prepared and submitted to Entomological Societies of different countries, with carefully prepared plans for the election of officers, the formation of the Executive Committee and other details of organization not yet provided for.

As delegates we wish to emphasize the value of the social features of the Congress, and to express the belief that such meetings will be of great ultimate advantage to entomological science in bringing together the entomological workers of different countries. We wish also to express our appreciation of the cordiality of the local representatives.

In accordance with directions from the Society we presented the invitation to the Congress to meet in America for its next session, but the question of place of meeting, had evidently been determined by the Executive Committee, and while our presentation of the case was listened to, there was evidently no chance to secure a favorable decision for the next Congress. We were assured, however, that the Congress would hope to meet in America in the near future, and it seemed well understood that an invitation to meet in America in 1918, would receive cordial response and favorable action.

The next Congress is to be held in Vienna in 1915, under the presidency of Dr. Handlirsch.

Signed HERBERT OSBORN, STEPHEN A. FORBES,
PHILIP P. CALVERT, L. O. HOWARD.

REPORT OF COMMITTEE ON NOMINATIONS.

Your committee begs leave to report the following names as nominees for the respective offices for 1913:

OFFICERS.

President: C. J. S. Bethune, Ontario Agricultural College, Guelph, Ontario.
First Vice-President: Philip P. Calvert, University of Pennsylvania, Philadelphia, Pennsylvania.
Second Vice-President: William M. Marshall, University of Wisconsin, Madison, Wisconsin.
Secretary-Treasurer: Alexander D. MacGillivray, University of Illinois, Urbana, Illinois.

ADDITIONAL MEMBERS OF EXECUTIVE COMMITTEE.

Herbert Osborn, Ohio State University, Columbus, Ohio.
C. P. Gillette, Colorado Agricultural Experiment Station, Fort Collins, Colorado.
Vernon L. Kellogg, Leland Stanford Jr. University, Stanford University, California.
James G. Needham, Cornell University, Ithaca, New York.
C. T. Brues, Harvard University, Cambridge, Massachusetts.
Nathan Banks, United States National Museum, Washington, D. C.

MEMBER OF COMMITTEE ON NOMENCLATURE.

E. P. Felt, New York State Entomologist, Albany, New York.

(Signed) HERBERT OSBORN,
R. A. COOLEY,
CORNELIUS BETTEN.

On motion, the secretary was instructed to cast a single ballot for the officers named. They were declared elected.

REPORT OF THE COMMITTEE ON RESOLUTIONS.

Resolved, That we express to the authorities of the Western Reserve University and of the Normal School our deep appreciation of the courtesies extended this society;

Resolved, That the thanks of this Society be extended to Mr. E. H. Edwards for his generous assistance in arranging rooms for our use at the Normal School as well as his personal help toward the success of this meeting;

Resolved, That we commend the Editorial Management of the Annals of this Society and hereby recognize the value of Professor Osborn's painstaking work in furthering the interests of this publication.

Signed S. J. HUNTER,
W. A. RILEY,
L. B. WALTON.

On motion the report was adopted.

Upon the recommendation of the Committee on Resolutions of and by action of the Society at the Washington meeting, the following committee on types was appointed. Their report follows:

REPORT OF THE COMMITTEE ON ENTOMOLOIGCAL TYPES.

Your Committee, appointed to report on Entomological Types, submits the following:

Location of Types. According to reports kindly furnished by the Directors or Curators, some of the larger museums of this country contain types as follows:

U. S. National Museum. About 16,000.

Museum of Comparative Zoology. Over 10,000.

Philadelphia Academy and American Entomological Society. About 7,100.

Dr. Skinner states that this includes only holotypes and lectotypes. It is believed that the combined Philadelphia collections probably contain 35,000 "types", counting all the cotypical, paratypical and typical specimens.

Carnegie Museum, including Dr. Holland's collection (on deposit). About 4,000.

The number owned by the Boston Society of Natural History (several hundreds, at least), American Museum of Natural History and Museum of the Brooklyn Institute cannot be given at the present moment, but will be ascertained later. A list of the types of insects, other than Lepidoptera and Formicoidea, in the American Museum has just been published (Bull. Amer. Mus. Nat. Hist. XXXI, pp. 253-379). The Milwaukee Public Museum has 71 types. Doubtless the British Museum has more insect types than any other museum in

the world, but there is no catalogue and the number is not known, even approximately. The New York State Museum at Albany possesses a large number of types under the care of the State Entomologist. A catalogue was published in N. Y. Museum Bulletin 141 (1909) pp. 119-122, but Dr. Felt informs me that probably about 700 Cecidomyiidæ are to be added. Stanford University has about 500 types, the majority Mallophaga.*

There are some very large private collections, such as those of Dr. William Barnes at Decatur, Illinois, (890 types), Dr. Nathan Banks at East Falls Church, Va., (about 1500 types and about 300 cotypes or paratypes) and Col. Thos. L. Casey. In the above estimates cotypes or paratypes are in nearly every case reckoned as types.

Opinions on the Location of Types. We have sought to ascertain the opinions of representative entomologists regarding the location of types, and cite the following as examples:

"We believe that privately owned types should eventually go to some good museum."—H. Skinner.

"I consider it unwise to make any suggestion as to restricting types to certain institutions."—S. Henshaw.

"I believe that it should be the policy of authors to place their types where they will be cared for in the future."—W. J. Holland. (See also The Conservation of Types, First International Entomological Congress, p. 366, where six museums are named as the only ones in the United States to which types should be consigned).

"I do not believe that types should remain permanently in private collections."—W. M. Wheeler.

"I do not see how any fixed rules regarding the distribution of types can be made, nor can we prohibit them from being private property. With many a zoologist his collection and books are his only assets, and while he is working they are probably doing as much good in his own collection as in a public museum. When I am through with my collection I want it to go into the hands of a dipterist."—C. W. Johnson.

"It would be of course a very good thing to have the types in a limited number of public institutions, or still better in one only, but I am afraid this ideal condition will never be reached. In regard to a privately owned type, I am of the opinion that as soon as a new species is described the type becomes public property, and the author, if he keeps it in his own collection, should take great pains to keep the type safe and in good condition, and provide sooner or later for a resting place in a public institution."—Chas. Schaeffer.

"Personally I am inclined to the view, that types ought to be restricted to as few institutions as possible. As to the number of these or how they should be selected, I have no opinion."—S. Graenicher.

"We deposit all particularly perishable types (such as pinned insects) in the U. S. National Museum."—A. G. Ruthven, Head Curator, University of Michigan Museum.

* Since the report was read, the University of Kansas has reported the possession of 897 types and 30 cotypes, etc. The University of Kansas does not loan types.

"It seems to me that the committee ought to strongly urge the designation of only one specimen as type, and that all such types should be put in institutions easy of access, having fire-proof buildings and careful curators."—F. E. Lutz, American Museum of Natural History.

"I think that insect types ought to be especially available to the men most active in working with the groups represented by them. If these men are in or near the greater museums, then the types should be in these museums. My belief is that the types should be where they can be and will be most effectively used."—V. L. Kellogg.

"Respecting types in general, I believe that they should be most carefully cherished and available for study by any competent party. The ideal arrangement would be to deposit all such types at some central point, for example, the National Museum, but as matters are now I fear this is impractical. Even were I personally willing to deposit all my types in the National Museum, I do not believe that the parties responsible for the integrity of the Museum and its collections would for a moment consider such a proposition. In any event, I should not care to part with types until certain that my studies in the group were completed. You can readily understand that in many cases it would be extremely difficult to fix any such date. It seems to me very desirable to segregate, so far as practical, the types of any one group; for example, the type of a single species of Coleoptera might much better be deposited in a large collection where there are numerous types of allied forms, than retained in some other collection possibly equally extensive, with practically no other type material in that order. My reason for suggesting this is that it is so easy by scattering types in widely separated groups for them to be lost unless they are in some collection known to be valuable because of the large amount of such material it may contain. It should at least be possible to deposit co-types with workers in special groups or in our larger collections, for example, those of the National Museum."—E. P. Felt.

"In general I do not approve of types being held by private individuals where the collection is not properly looked after and liable to destruction at any time (*vide* the French collection, which is now *totally* destroyed by Dermestes, types and all). Of course in Dr. Barnes' case it is different. His collection has assumed museum proportions just as the Walsingham collection in England."—J. McDunnough.

Location of Types in the Collections. In nearly all collections, so far as we have ascertained, the types are placed in the systematic series. At the British Museum certain special collections, as the Banks collection (types of Fabricius) and the Wollaston collection (Coleoptera from the Atlantic Islands) are kept separate; while other types are in the accession drawers or in special cabinets, awaiting the rearrangement of the groups to which they belong. At the Museum of the University of Michigan all types (including cotypes and paratypes) are kept together in a fire-proof case on the first floor of the building. They are, however, not very numerous. At the Carnegie Museum the Ulke collection of Coleoptera remains in the boxes exactly as received from Mr. Ulke, and the Smith collection of Brazilian bees studied by Cockerell

is also still as received from that author. At the Museum of Comparative Zoology some recent accessions have not yet been placed in the series.

It is the nearly universal policy not to separate the types from the rest of the collection.

Labelling of Types. It is usual to label the types, and in no case is it the regular policy not to do so. In some of the older collections the types are not, or not all marked. In several instances the labelling of the types has been done by curators after the collections had passed out of the hands of the describers. This has of course been necessary, but it has not always been carefully done, and we know of cases, in large museums, where so-called types are either not of the same species, or from the same locality, as the specimens originally described under the name.

Red is the favorite color for type labels, but great diversity prevails. Some museums have different labels for types, cotypes, etc. A sheet of type-labels is appended for inspection at the meeting. The U. S. National Museum has special red labels for slides and alcoholic specimens.

Catalogues of Types. Some institutions, as the American Museum of Natural History and the New York State Museum, have published partial or complete catalogues of their types. In many, such as the U. S. National Museum, a manuscript catalogue is kept, and each type receives a number. Some institutions have no catalogues; several report one in progress. At the British Museum the types are not catalogued, except in the published catalogues of the Museum, such as that of Sir G. F. Hampson, which will when complete cite all the types of moths.

Loaning Types. The following replies have been received in answer to our questions:

"It has never been legal for a type to leave the building, and the rule has been invariably enforced."—G. Meade-Waldo, British Museum.

"Recently the rule against the loaning of holotypes has been enforced. Cotypes or paratypes are loaned when we have the type or others of the same sort. If, however, the cotype or paratype is the only type specimen we have it is treated as a holotype, i, e., not loaned."—J. C. Crawford, U. S. National Museum.

"The American Entomological Society does not loan unique types." The Philadelphia Academy treats each case on its merits.—H. Skinner.

"All M. C. Z. rules are elastic, but we do not loan types except there is especial reason for so doing."—S. Henshaw, Museum of Comparative Zoology.

"The Society has loaned types; whether it will continue to do so is a question."—C. W. Johnson, Boston Society of Natural History.

"There is a rule against sending types out of the Museum, though the Director has loaned his private types."—Hugo Kahl, Carnegie Museum.

"It is against our rules to loan types."—C. Schaeffer, Museum of Brooklyn Institute.

"We do not make a practice of loaning type material." E. P. Felt, New York State Museum.

"We do not loan holotypes. We do loan cotypes and paratypes." V. L. Kellogg, Stanford University.

"We have a rule against loaning types. When, however, all the following conditions exist we do occasionally send them out. The borrower must be a trustworthy man who cannot conveniently get to New York. The specimens must be of such a character that they would not be likely to be injured in transportation, and there must be a series, all of which are designated "type" by the author. The latter seems to be a bad practice, but when there is such a series and the other conditions are met we have occasionally sent out one or two specimens." F. E. Lutz, American Museum of Natural History.

"I think the question of loaning types is a delicate one. I believe in institutions loaning them to thoroughly accredited persons and under very stringent conditions."—W. M. Wheeler.

The Milwaukee Public Museum has no rules governing the loan of types.

Fireproof Buildings. Experience has shown that so-called fireproof buildings are sometimes destroyed by fire. Nevertheless, the following information is of value. The new National Museum "is absolutely fireproof, the only wood in construction being a skin floor on the top floor and wooden window casing on this same floor. The doors are of steel. The only thing that would burn is the exhibits, and, in the case of insects, we store them in steel cases, making it impossible for them to catch fire if anything exposed should burn." It should be said, however, that very large alcoholic collections are kept in the basement. At the British Museum the collections of fishes and reptiles (except the public exhibits) are in a separate building, on account of the danger from fire. It is hardly conceivable that a fire among the alcoholics in the basement of the U. S. Museum would effect the insects, which are on an upper floor.

The American Museum of Natural History "is as completely fireproof as it is possible to be made."

"The collections (of the New York State Museum) at the present time are not in a fireproof building, though we expect to move within a few months into a thoroughly modern fireproof structure."

"The Museum of the Brooklyn Institute is considered fireproof."

"The Carnegie Museum building is fireproof."

The Museum of Comparative Zoology building was considered fireproof when examined by insurance experts.

The Philadelphia Academy building "is built of brick, steel and concrete; the upright steel girders are covered with terra cotta and then cemented. The main rooms and floors are all separated by automatic fire doors. The floors are concrete with no wood."

RECOMMENDATIONS.

Location of Types. It is necessary for the progress of entomology that specialists should frequently have in their possession collections containing many types, and experience shows that so long as these collections are in use the types are reasonably safe and well cared for. Ultimately, however, these types should find a place in some large public museum, where they will be preserved for the use of posterity. If entomologists are expected to make arrangements looking toward the placing of their types in public museums, they have the right to demand that these museums shall be made fully competent to take care of them. Not only must the buildings be practically fireproof, and the cabinets adequate, but there must be a staff large enough to take care of the specimens and keep them in order. Types should never be deposited where a continuous succession of competent curators (entomologists) cannot be depended upon.

Location of Cotypes and Paratypes. New species of insects are frequently described from considerable series of specimens, designated cotypes or paratypes. Authors would probably be glad to distribute some of these among the principal museums or collections, if convenient arrangements existed for doing so. Such distribution would greatly facilitate entomological work, and we suggest the desirability of considering whether some distributing center cannot be organized.

Location of Types in Collections. We believe that types are best kept in the systematic series, where they can readily be found and compared with their allies.

Labelling of Types. It is highly desirable that uniform labels should be used for types. Among those submitted for examination, the circular labels with colored margins, from the British Museum, seem to have a sufficient degree of distinctness to enable them to be readily seen, without the rather offensive conspicuousness of some other labels. There should, however, be a place for the type number.

Cataloguing Types. Every museum should catalogue its types, giving each a number. It is very desirable to publish the catalogue, with supplements from time to time. We also suggest that lists of the types received during the year would be useful additions to museum reports, and might well replace some of the worthless information which these usually contain.

Loaning Types. We are of the opinion that holotypes, or specimens designated as *the type* should under no circumstances be loaned; but cotype or paratype material should be loaned under proper restrictions.

Permanent Committee. We suggest that the type committee be made permanent, with changing membership, like the committee on nomenclature, and that its members be requested to examine and report on museums and collections as opportunity offers.

Signed T. D. A. COCKERELL
L. O. HOWARD,
HENRY SKINNER.

On motion, the report was ordered accepted and printed, and the committee continued for another year.

The following papers were then read:

Edith M. Patch and William C. Woods, Maine Agricultural Experiment Station: A Study in Antennal Variation. Read by title.

Alex. D. MacGillivray, University of Illinois: Propharynx and Hypopharynx.

The pharynx after entering the occipital foramen makes a distinct bend toward the mouth. In the region of the clypeus, it divides transversely, one-half passes to the clypeo-labral side, the other half to the labial side of the mouth, while folds extend along each lateral margin and unite with the mandibles and maxillæ. The name of propharynx is proposed for the portion lying adjacent to the clypeo-labral part of the mouth and hypopharynx is used for the portion lining the labial portion. The propharynx consists of three parts: frontal lobe, epipharynx, and fulcrum. The frontal lobe is usually wanting in sucking insects, the epipharynx is modified into a tongue or piercing organ and the fulcrum into a cuticular supporting plate. In the muscids the epipharynx and fulcrum are located outside of the mouth, the proximal end of the fulcrum is attached to the distal margin of the labrum. The hypopharynx also consists of there parts; lingua, superlingua, and pharyngeal sclerites.

F. L. Washburn, State Entomologist, Minnesota: A few Experiments in Photographing Living Insects.

Thomas J. Headlee, New Jersey Agricultural Experiment Station: Some Facts Regarding the Influence of Temperature and Moisture changes on the Rate of Insect Metabolism.

While connected with the Kansas State Experiment Station at Manhattan, the writer found by subjection of different groups of the Southern Grain Louse (*Toxoptera graminum* Rodani) to various constant temperatures under constant atmospheric moisture conditions and other groups to various constant percentages of relative humidity under constant temperature conditions: (1) that the rate of increase in metabolism for each 10°F. increase in temperature, starting at 58°F., decreases as the optimum temperature is approached, and that while the metabolism of degeneration becomes more rapid after the optimum is passed the rate of growth is retarded; (2) that a variation of from 60 to 62% in atmospheric moisture does not effect the rate of metabolism when the creatures have an abundant supply of succulent food.

Similar tests of the effect of temperature on the rate of metabolism in *Lysiphlebius tritici* Ashm, and of the effect of temperature and moisture on the rate of metabolism of the Chinch Bug (*Blissus leucopterus* Say) infected and uninfected by the chinch-bug fungus (*Sporotrichum globuliferum* Speg.) gave similar results.

J. T. Abbott, Washington University: The Strigil in Corixidæ and its Probable Function. Read by Title.

Edna Mosher, University of Illinois: The Anatomy of Some Lepidopterous Pupæ. (Presented by Mr. Alvah Peterson).

Figures of pupæ of three species were shown and described. *Sthenopis thule, Archips argyrospila, and Lymantria leucostigma.* Figures of the pupal cases of each of these species were shown, also figures of the pupæ, with the cases dissected away so as to show the parts underneath. Considerable difficulty has been encountered in homologizing the pupal structures from the external appearance particularly in the case of the fixed parts of the head and the appendages of the head and thorax. The leg cases were shown to be a frequent source of error. Instead of showing externally only the cases for the tibiæ and tarsi, as Scudder claims is the case in the butterflies, certain forms show the femur cases and either the whole or part of the coxal cases in certain pairs of legs. What Packard calls the paraclypeal pieces, were shown in these forms to contain functionless mandibles which had their distal margins toothed in the case of *Lymantria*.

This detailed anatomical study is to be made the basis for a phylogenetic and taxonomic arrangement of the Lepidoptera based on an examination of the characters of the pupæ.

Charles K. Brain, Ohio State University: Some Anatomical Studies of Stomoxys calcitrans Lin. (Introduced by Professor Herbert Osborn). Printed in part in December Annals. Part II will appear in June Annals.

S. W. Bilsing, Ohio State University: Observations on the Food of Spiders. (Introduced by Professor Herbert Osborn)

Spiders are known to feed upon insects but exact records of kind and quantity of food for particular species are very meager. Extended observations and records were made during the summer and fall of 1912 and data from some of these are presented. As an example of the records given, grasshoppers constituted 39% of the food of *Miranda aurantia*, 59% of the food of *Agalena nævia* and 22% of the food of *Aranea trifolium* during the period under observation.

Herbert Osborn, Ohio State University: Observations on Insects of a Lake Beach.

The Insect fauna of the Cedar Point Beach of Lake Erie is discussed with reference to its derivation and adaptation for the conditions presented. The insect drift, the migrant and the resident members of the association are separated and records of species in each group given.

C. H. Tyler-Townsend, Government Entomologist of Peru: The Species-Status and the Species-Concept. Read by Title.

C. H. Tyler-Townsend, Government Entomologist of Peru: A New Application of Taxanomic Principles. Read by Title.

A smoker was held in a grill room of the Hotel Euclid after the annual public address, by a number of the entomologists in attendance at the meetings.

The annual public address of the Society was given on Wednesday evening, January 1st in the Auditorium of the Normal School by Dr. Philip P. Calvert, University of Pennsylvania.

The following exhibits were shown:

R. D. Glasgow, University of Illinois.—Apparatus for orienting insects under the microscope.

F. E. Lutz, American Museum Natural History.—Professor T. H. Morgan's mutants of *Drosophila ampelophila*.

Herbert Osborn, Ohio State University.—Some examples of Cicadidæ, especially the Ohio species of the genus *Cicada*.

N. L. Partridge, University of Illinois.—Pupal wings of *Attacus cecropia*.

Victor E. Shelford, University of Chicago.—Experimental modification of the colors and color patterns of *Cicindela*.

Alex. D. MacGillivray, University of Illinois.—The propharynx and hypopharynx of a cockroach, a locust, and a hornet.

F. L. Washburn, State Entomologist of Minnesota.—Snap shots of living insects in the field.

Anna H. Morgan, Mt. Holyoke College.—Drawings of the eggs of May-flies.

On motion, the Society adjourned to meet in one year with the American Association for the Advancement of Science at Atlanta, Georgia.

ALEX. D. MACGILLIVRAY,
Secretary.